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OBSERVATIONS ON VALLONIA.

BY DR. V. STERKI.

The genus *Vallonia*, established by Risso¹ as early as 1826, has been generally accepted only of late years. It has been ranged under different groups of *Helix* by various writers, and later regarded as a subgenus. In America, Morse² was the first to treat it as a genus, and he was followed by W. G. Binney (Manual Am. Land Shells, p. 76).

Acanthinula Beck and *Vallonia* have been united by Kobelt, and after him by Dr. v. Ihering³ to form *Theba*, a subgenus or genus of *Helix*. Pilsbry, in his Check-List,⁴ has placed *Acanthinula* as a section under *Patula*, and *Vallonia* as a section under his subgenus (or genus) *Polygyra* (Say), but subsequently⁵ he regarded *Vallonia* as a genus.

There are a few points known of the anatomy. The absence of a secondary ureter, according to Braun and Boehme, as cited by v. Ihering,⁶ is characteristic. As to the genitalia, a dart sac is said to be present, and there is a flagellum to the penis; glandulæ mucosæ were not found by Lehmann or by Moquin-Tandon, as cited by v. Ihering (*l. c.*), yet appear to be present, as Pilsbry (*l. c.*) ranges our genus under the group *Belogona* ("with dart sac and mucous glands"). Further anatomic examinations of all the soft parts of the body are necessary. My own observations are not ready for communication.

The comparatively large number of species and forms known at present, all somewhat similar as to the shell and the rather characteristic and uniform configuration of the radula and jaw, tend to prove the individuality of the group as a genus, and that it is a well-defined one.

¹ Hist. Nat., de l'Eur. Mérid., iv, 1826.

² Observations on the Terrestrial Pulmonifera of Maine. Journ. Portl. Soc. of Nat. Hist., 1864, pp. 4 and 21.

³ Morphologie und Systematik des Genitalapparates von *Helix*. Zeitschr. f. wiss. Zool., 1892 (pp. 386-520, pl. xviii and xix) p. 480.

⁴ Nomenclature and Check-List of North American Land Shells. Proc. Acad. Nat. Sc. Philadelphia, 1889, pp. 191-210.

⁵ Preliminary Outline of a new classification of the Helices, Ibid., 1892, p. 396.

⁶ *L. c.* and Les relations naturelles des Cochliques et des Ichnopodes. Bull. Scientifique, Paris, 1891, p. 214.—Unfortunately, Lehmann, *lebende Schnecken*, is not accessible to me.

As with the genus so it was with the species ranged under it. Müller⁷ described "*Helix*" *pulchella* and *costata*, and for nearly a century, even up to our own time, almost all writers united them in one species, under one or the other of the two names, generally *pulchella*, regarding the other form as varietal. The fact alone that the two forms, evidently of very ancient origin like the whole genus, have persisted as such, side by side almost everywhere, over a very wide area, is sufficient to prove their distinctness, not to speak of the really marked differences of the shells. Only in the last decades, however, has this conviction become prevalent; and in America, Morse (*l. c.*) was the first to express this opinion. On closer study, conchologists admitted that there are quite a number of other species besides the two "standard" ones.

But of many of them it is difficult to judge. 1. Their anatomic characters have not, especially the genitalia, been studied sufficiently, and it is not known whether they present any specific peculiarities⁸ apart from those of the jaw and radula. 2. The material at hand, considering the shells alone, is insufficient to allow the formation of a judgment whether certain forms are species, varieties, or mere local variations and mutations. 3. The shells in this genus are so uniform in size, shape and color, that it takes careful comparison to become familiar with the forms and their peculiar features, as well as the ranges of variation.

When Mr. Pilsbry requested me to study the genus, I knew very little about it, and was disposed to decline. After a conscientious study of the material at hand, and the literature accessible, I believe I have effected something to promote our knowledge of these minute and interesting mollusca. This paper, in the absence of anatomical study and of specimens of many published species, is not a monograph of the genus. It may, however, serve as a guide to further investigations.

To Mr. H. A. Pilsbry I am especially indebted for much information, references to literature, etc., and I take this opportunity of tendering him my hearty thanks.

GENERAL DESCRIPTION.

Soft parts.—They are, in general aspect, like those of *Helix*, but, as already pointed out, there is no secondary ureter. A few other

⁷ O. F. Müller, *Vermium Historia*, 1774, pp. 30, 31.

⁸ Such differences, however, may be looked for as probable, as such have been found among nearly related species of other groups; *conf.* e. g. v. Ihering's book on the genital apparatus of *Helix*, cited above.

features have been indicated above and will not be repeated here. Owing to the kindness of several conchologists, I have had living examples of a number of species—*V. pulchella*, *excentrica*, *costata*, *parvula*, *albula*, *perspectiva*—and I have, besides observing the animals, examined the jaw and radula, necessarily deferring further anatomical studies.

The *foot* is small in proportion to the shell, being scarcely as long as the diameter of the latter in the species seen. It is colorless, translucent, as is also the head, so that the internal parts are seen rather indistinctly from above—the jaw, buccal body, oesophagus, with morsels of food and numerous minute air bubbles at times passing it, and even the cerebral ganglia being observable with a good lens. A fine, raised median line extends from the head over the neck. A very fine but distinct line makes a narrow margin or seam above the longitudinal edge of the disc or sole, which shows about 8 to 10 distinct crenulations on either side from head to posterior end. The raised parts are separated by very fine lines, grooves or hyaline septa, which, on the posterior part, have somewhat the appearance of an inverted honey-comb, as the septa are impressed. At the tail a slight groove, like a rudimentary mucous pore, seems to be present. I could not determine distinctly separated or defined longitudinal areas in the sole, so that there is no true locomotive disc as described by W. G. Binney, the whole sole being probably comprised in such a disc, since the lateral parts are wanting, as in many *Hyalinia*, etc. The locomotive waves or undulations extend over the whole width of the disc, and even on the margin above, succeeding each other rapidly and often somewhat irregularly, advancing from the posterior end, about five at the same time. They were seen when the animal was retiring in the shell and only the posterior part of the foot still projecting and not attached to anything. In the sole are seen numerous very small white dots, such as are found in almost all our land and fresh water Gastropoda.

The *eye-peduncles* are slender, very little if at all thickened at the ends, glassy, with very finely granulated surface; inferior tentacles short but distinct. There are two rather large horizontal flaps or lappets at either side of the mouth, but their margins are not crenulated as in *Acanthinula harpa*. In several species, such as *pulchella*, *excentrica*, *albula*, I found the edge of the mantle slightly colored with a rusty pigment at the periphery, but varying in the different forms; probably it will be found in all species.

The *liver* in *pulchella* and other species is light yellow, normally, but lighter or darker brown in some specimens. The latter color I first thought to be caused by certain kinds of food, or by a certain stage of digestion, but it lasted for several days, and even weeks, during which the snails were confined and apparently not feeding, therefore too long to admit of this explanation. It is probable that the deeper coloration is caused by a degeneration, or incipient decomposition of the organ due to old age, as I have seen it in dead as well as in living specimens of this and other species and genera of land shells. Observations in this line, checked by microscopic examinations, should be made on *Vallonia* and other forms.

The *ovotestis* is extended all along the liver, up to the apex, making numerous intersections. The ganglia were not examined thoroughly. They seem to be of a somewhat peculiar type. In *V. parvula* (and other species) the cervical masses are adjacent to each other in nearly their entire length, and from these short commissures are seen to be closely connected, probably visceral ganglia on either side, while from the latter, long commissures extend to the pedal ganglia respectively. These are of the form figured by Leidy in Binney's Terr. Moll. I, Pl. IX, f. vii (of *V. pulchella*). The rather large, pear-shaped stomato-gastric ganglia are not adjacent to each other. It may be added that I found parasitic worms, such as probably infest all mollusca, in a half grown *V. pulchella*; there were several comparatively large species.

The *jaw* is more or less arcuate, about 4–6 times wider than high (in *V. pulchella*, e. g. 0.23 wide, 0.064 high) rounded or slightly angular at the ends, comparatively strong and partly of deep horn or chestnut color in some; thin, flexible and pale in others (e. g. in *perspectiva* and *albula*). The coloration is always deepest in the inferior part, gradually fading from about the middle upward, so that the superior edge is nearly or quite colorless. Sometimes it has a slight, wide median projection to the cutting edge, as in *V. excentrica* (Plate VIII, fig. M), and as also indicated by Moquin-Tandon for *V. pulchella*. If this character be constant in *excentrica*, we must suppose that the French author chanced to examine an example of this species, which is widely distributed over Europe and has been confounded with *pulchella*. The anterior surface is somewhat convex perpendicularly, as seen in figs. K and L, Pl. VIII, and bears more or less fine and crowded ribs, about 18–25 in number,

stronger and somewhat irregularly distributed, irregularly denticulating the superior and inferior or cutting edges. In fig. I, Plate VIII, they are exactly drawn from a jaw of *V. pulchella*, enlarged about 300 diam., and it is distinctly seen that one rib stands regularly on either side of the not otherwise marked median line, being more distant in the superior part, then approximating to near the cutting edge. The other ribs, about 12 on either side, stand somewhat irregularly, sometimes in pairs. Near the ends of the jaw they become, rather abruptly, quite fine, visible only under strong enlargement, so that otherwise these parts appear to be smooth. Whether this formation of the jaw is derived from a goniognathous one in the embryonal stage remains to be determined, but it is probable, the more so if we compare it with the jaw of *V. parvula* (Plate VIII, fig. R). There the ribs, especially those on the middle of the lateral parts, were not simply and symmetrically raised, but their sides are steep, abrupt outward, more gently sloping inward. Thus they give the impression of plates originally separated and grown together by subsequent growth.

In the middle and upper part of the jaw, very fine, dense, somewhat irregular, horizontal "striae," apparently undulating, evidently lines of growth, corresponding with the ribs, are visible.

From the main plate or jaw proper, a rather strong posterior plate springs from the whole inferior or cutting edge, extends backward without interruption and tapers into the long and strong hyaline tenaculum membrane of the jaw. It evidently serves to reinforce the jaw, and especially the cutting edge. Plate VIII, fig. I, shows it as seen from the front through the main plate, from *a* to *b*, on one side, both its contours being plainly visible. When the jaw is resting on its front side the posterior plate may conceal the cutting edge from sight, and then the latter appears to be quite even, not denticulated, especially so in the median part. How far this formation of the jaw is present in other land-pulmonates, I do not know—very probably there are many intermediate stages. In *Patula striatella* I have found it almost exactly the same as in *Vallonia* and in the *Zonitidae*; in *Zonitoides ligera* Say, there is a distinct indication of it, though with some modifications.

The jaw, especially in the species where it is comparatively stout, presents quite different aspects, according to the side and direction from which it is viewed. Thus we may understand partly the fig-

ures of Morse (*l. c.*, *V. minuta*), of W. G. Binney,⁹ in which, in harmony with the descriptions, the superior and cutting edges have evidently been mistaken for each other. The jaw was somewhat softened by strong caustic alkali, and the object drawn was evidently extended by pressure.

The *radula*, or lingual membrane, bears markedly different central, lateral and marginal teeth. I found from 23–33 in a transverse row, the former number in *cyclophorella* and *perspectiva*, the latter in *parvula*. Morse counted 23 in *minuta*, W. G. Binney 21 in *pulchella*. The difference may be partly explained by the rather strong enlargement used by me, and partly by local variations. The number of transverse rows varies from 63 in *cyclophorella* to 84 in *excentrica*, and there is, as everywhere, some individual variation. The size of the *radula* is not always in proportion to the shell. In *pulchella* it is about 0.68 mm. long, and 0.24 wide; in *excentrica* with the shell rather smaller, the dimensions were found 0.79 and 0.24 respectively. One transverse row measures 0.01–0.011 in length, while only 0.009 in *perspectiva*.

The central tooth is small, its plate of attachment narrow, as long as the row space, the posterior end somewhat wider in various degrees. If not carefully examined, this may appear so in a higher degree than it really is, since the plate is not exactly in the same level. The side edges of the posterior end are curved up and the angles are projecting like cusps. Plate VIII, fig. P, shows a central tooth of *V. parvula* viewed in half profile with these angles projecting almost beyond the level of the cusps. The reflection at the front end is small, short, and bears 3 cusps, the median about $\frac{1}{4}$ – $\frac{1}{3}$ as long as the plate. The side cusps are very small, sometimes hardly perceptible. There are, as a rule, 3–4 perfect laterals, bicuspid, a larger mesodont and a small ectodont, the former with a distinct free cutting point, the latter with just a trace of it. The plate of attachment is almost as wide as long, and the posterior part of the edge is curved up, as in the centrals, with the angle projecting, also like a cusp. It doubtless acts as such, since in the oldest teeth, where the cusps are nearly worn off, the same is true of these posterior distal angles, including those of the central tooth as represented in Pl. VIII, fig. G. On the fourth or fifth tooth sometimes the remains of the two cusps are no longer coherent,

⁹ It is evidently the same cut, but in different position; and it must be noted that Morse, *l. c.*, in all his figures, has the cutting edges above, while W. G. Binney in his Manual, has them directed downward.

but isolated in this state. In the first lateral the mesodont is large, as long as the plate or more so; then it becomes gradually shorter till in the last perfect lateral it scarcely reaches beyond the middle of the plate. The ectodont is always small, but in some instances I have seen it longer in the last lateral than in the one preceding. W. G. Binney says (*l. c.*) that the posterior mesial (inner) angle of the plate is suppressed. As a rule, I could see that angle well formed in isolated teeth, although not projecting.

Outside of the laterals follow 2 or 3 *transition teeth*, of which at least the first mesial might range with the laterals, as there is a well formed though somewhat shorter plate with the distal angle not projecting and two cusps; the mesodont becomes longer again and the ectodont simple or subsimple, but finely double-pointed, which splitting becomes more marked in the next following tooth, thus resembling more the true marginals (Pl. VIII, A, 5 and 6, B 5, C 5 and 6, D 7, E 6, F 6.)

The mesodont is of a peculiar formation in these transition teeth. As illustrated in Pl. VIII, A 4, B 5, C 5, D 5 and 6, F 4 and 5, it becomes obvious that the true mesodont is rather disappearing, while, in fact, a different cusp, another element, grows out from it, or rather, on the mesial side of it, in close connection with the plate of attachment, which then becomes the mesial cusp of the true marginals, in which the plate of attachment does not reach beyond the reflection. In these, the distal cusps, corresponding to the multiplied ectodont, increase in number up to 3-5 and even 6, gradually becoming smaller and obsolete toward the distal end of the single tooth as well as of the row; so that, as a rule, the last tooth is simply a small, wide, transverse bar, without any perceptible cusps. At the same time these cusps become longer, like the teeth of a comb, so that the marginals may be said to be rather *pectinate* than serrate. In some species, there is a peculiar formation of the middle marginals, especially in *V. excentrica* (Pl. VIII, fig. B, 7-10), in which the cusps do not stand singly on the base, but on a common socle, thus giving the tooth a fan-like appearance. The same is seen, but in a lesser degree, in *V. cyclophorella*, Pl. VIII, fig. E, 7-11. In these teeth the mesial cusps are particularly directed inward.

Shell.—It has already been said that the shells of all the Vallonia species are remarkably uniform—there is moderate diversity in size, the smallest averaging 2.0 (some specimens 1.7) the largest about

3.5 mm.; all are openly and rather widely umbilicated; the number of whorls varies only between 3 and $4\frac{1}{2}$ at most; the coloration is from colorless to pale or reddish horn, or to light gray. Yet there are some features likely to sufficiently characterize the different forms, even better than are those of most groups of *Helix* with much larger shells. The umbilicus may be rather narrow from its beginning, or very wide, distinctly showing all the volutions, as in *V. perspectiva* and some varieties of *costata*. Usually it widens considerably and rather abruptly, with the last $\frac{1}{3}$ – $\frac{1}{2}$ whorl receding to the periphery below; sometimes this receding is not effected in the part of the last whorl close to the aperture, but earlier, to keep in a more regular circular or spiral direction in the last part, or even to turn inward and thus again narrow the umbilicus; it is thus in *V. cyclophorella* and *tenuilabris* (i. e., the Kroellwitz shell, Man. Conch., Pl. 33, fig. 31) for instance. The peripheral outlines of the shell, as well as the umbilicus, sometimes are distinctly elongate in direction, not of the larger diameter, but of one cutting off a part of the last whorl (Man. Conch., Pl. 33, fig. 35). There is also in the species named and in *V. costata* var. *pyrenaica*, a slight but distinctly marked obtuse angle in the peripheral outline, about $\frac{1}{3}$ of a volution above the aperture (Man. Conch., fig. 30, 34). In *V. excentrica* the umbilicus is narrowed by the last whorl, and then widened (fig. 8) while above, the aspect of the shell is quite different from that of the species mentioned (Man. Conch., Pl. 33, figs. 32–35). These characters may appear trifling, but they essentially characterize the different forms, and must impress themselves upon any one examining and comparing great numbers of *Vallonia*. In comparatively few forms the umbilicus shows a regular or approximately regular spiral, as in *V. declivis* (and *altilis*), and also in some varieties of *costata* (*helvetica*).

As has been pointed out by different authors, the last whorl is often decurved or descends toward the aperture, and that in the majority of species. But it does so in different degrees and ways which are very characteristic and deserve our special attention. 1. The lateral $\frac{1}{3}$ – $\frac{1}{2}$ whorl may simply, gradually and steadily descend, without a marked curvature of the middle upper part or “back,” as it will be called hereafter, of the whorl, and without a deepening of the suture, such as is seen in *V. declivis* (Man. Conch. Pl. 32, figs. 13, 16, 17), and in *V. pollinensis* Paul. (from the description). 2. In other forms only the suture descends or deepens, rather shortly and

abruptly to the aperture, while the back of the whorl keeps straight, horizontal (Man. Conch., Pl. 32, fig. 25) or even a little ascending, to the very margin, as we see it in *V. parvula*, and in some forms of *V. costata*, while in most of them, (3) as a rule, the whole whorl descends slightly (Man. Conch., Pl. 32, fig. 21). 4. Still others have the last whorl near the aperture markedly and decidedly entirely descending, so as to form a distinct curvature of the back as in *V. perspectiva* (Man. Conch. Pl. 33, fig. 42), *cyclophorella* (Man. Conch., Pl. 33, fig. 37) and others. The suture either descends comparatively more than the other part, or not so decidedly, as in the Kroellwitz *V. tenuilabris* (?) These formations have a marked influence on the shape and direction of the aperture, for the latter will necessarily be more inclined where the last whorl is strongly decurved. Where only or principally the suture descends, the aperture will be more circular, and less crescentoid, as becomes apparent at once if we compare *V. pulchella* and *excentrica* with *parvula* and *costata*.

In different forms the last whorl not only descends to the aperture, but previously to that rises more or less gradually to or above the niveau of the penultimate whorl (Man. Conch., Pl. 33, fig. 33, 37), thus causing the spire to appear somewhat papilliform, if the shell is viewed from the front. This we find most marked in *V. cyclophorella*, *tenuilabris* (Man. Conch., Pl. 33, fig. 32), and others in which the penultimate whorl appears narrowed above (Man. Conch., Pl. 33, fig. 30). This ascending is directly associated with rapid recession outward as seen in those species at the base. The same thing, though less strongly marked, is found also in many specimens of *V. costata*, and, not infrequently, in *pulchella*. We have in *Helix* (*Pedinogyra*) *cunninghami* Gray,¹⁰ a very illustrative model of the described configuration of the last whorl, especially on the upper side.

The *aperture* is described as being more or less oblique. We must here distinguish its direction as compared with the vertical axis of the shell, which may be called its *inclination*, from its direction compared with the horizontal axis, or its *obliquity*. The latter is very marked in *V. parvula* and *perspectiva* (Man. Conch., Pl. 33, fig. 42) and others, where a prolonged horizontal line through the aperture would just touch the circumference of the shell, that is, would be tangential, or cut off a very small part of it. We find the con-

¹⁰ In Tryon-Pilsbry, Man. of Conch., (2) VI, pl. 2, fig. 30, it is well shown, although not especially mentioned in the text (p. 12).

trary in *V. altilis* (Man. Conch., Pl. 32, fig. 17), where the aperture is also very little inclined.

As to the shape of the aperture, there are two principal groups of species—in one it is nearly circular, no wider than high or rarely so; in the other the transverse diameter is greatest, and the aperture is ovoid or pear-shaped. Most forms of the latter group have no thickened lip, as a rule, while those of the former may be of the same character, or provided with a more or less strong white lip. In a few forms the peristome is simple and straight, as in *V. pollinensis* and *V. altilis*, while in most it is everted (or “reflexed”) in various degrees and rather abruptly, as in *pulchella*, *costata*, etc., or more gradually as in *cyclophorella*. It must be specially noted that in all instances the peristome is straight above, not everted, at the suture and for a greater or less distance from it. This will not be repeated as a general character in the special descriptions.

It remains to say a few words in general about the structure of the surface of the shell. Ribbed and plain species have been distinguished, but there are all possible intermediate forms between these extremes, and it may be added at once that even in the same species considerable variation may be found, e. g., in *V. pulchella* and *costata*. What we generally call ribs are membranous elevations or duplicatures of the epiconch, and, properly speaking, they do not deserve that name. They vary from very coarse and rather distant, and equidistant, as in some forms of *V. costata*, to quite fine and crowded, and more or less irregularly set. I counted from 22 (*V. costata* var. *amurensis*) up to nearly 70 (in *V. cyclophorella*) on the last whorl. These membranous ribs generally stand on stronger striæ or fine ribs of the shell itself. But in some species there are rather strong true ribs devoid of membranes, as in *V. gracilicosta* Reinh. To what degree the variability may go is seen in *V. costata* var. *helvetica*, which has not a trace of membranous ribs and the “shell ribs” are very fine striæ, visible only with a good lens. It is not sufficient, then, to say in descriptions, that a shell is “ribbed” or “not ribbed,” but the character of the ribs must clearly be stated, as this is a prominent character. On the dead shells, and sometimes partly on the living, the epiconch loosens and becomes lost by the action of the water or atmospheric influences, and with it disappear the membranous ribs. Such specimens, mixed with more or less perfect ones, are especially found in drift materials along rivers and streams. It is unnecessary to say that fossil shells

are almost always in this condition, and it may be impossible to know whether they originally had such ribs or not, if they be of a form not represented in the recent fauna.

It seems that there are also differences in the surface sculpture of the nucleus or the (about $1\frac{1}{2}$) embryonal whorls. While in the ribless species—*V. pulchella*, *excentrica*, *declivis*—it is, as a rule, smooth, the ribbed *V. costata* and related forms have it marked with fine, rather dense revolving, raised lines (Man. Conch., Pl. 33, fig. 54), about 10 or less, on the visible part. Whether they are also present below the periphery of the embryonal shell I am unable to say.

Habits of the animals.—I have seen living specimens only of *V. pulchella*, *excentrica*, *costata*, *albula* and *perspectiva* (of the latter only one). They were kept in confinement for weeks. As we find mature and young specimens at all times, it seems that their propagation, as well as the duration of life, are not bound to a certain season. Their movements are slow and somewhat unsteady—evidently it is not easy to carry the comparatively large and heavy shell. It occupies 15–30 seconds in transversing a space corresponding to the diameter of the shell. They shun light decidedly, as do most of our North American land snails. I repeatedly observed individuals, when brought into day- or lamp-light, moving slowly with head and disc only a little projecting, the eye peduncles quite short; when they were shaded, the latter stretched out and the motion grew more lively; when in full light again, the animal became evidently uneasy, made a few quicker motions, and changed its direction. It was generally several seconds before perception was followed by motion. To judge also from other experiments, sight seems to be very imperfect. It is not only in this group of molluscs, but in others, quite unlike the sense of feeling, which is more acute.

The *heart* is, as in other mollusca, strongly influenced by temperature and the degree of general activity or rest. In a temperature of about 50–60° F., it contracts at a very slow rate, about 20–25 per minute, but variously in different individuals, as will be seen from the following observation: Of two mature *V. pulchella* lying on the table at a temperature of about 65° F., one had the heart contracting 72, the other 32 times per minute; after they had been on my warm hand for about two minutes, the heart of the former made 110, of the latter 68 contractions per minute. They are able to live under water for a considerable time, even for several hours;

it may be possible that the small body absorbs air or oxygen from that contained in the water. In one example which had been submerged for more than half an hour, the pulmonary cavity was completely filled with water, and the heart contracted at a rate of 74 per minute, in a temperature of about 65° F. The foot was stretched out and moving about, trying to get a hold, but the tentacles kept deeply retreated, the dark eyes being visible above the buccal body.

Vallonia has a very wide *geographical range*, being distributed all over the temperate region of the Northern Hemisphere. It is evidently an old genus, geologically, as it has been found fossil in many places, and its wide distribution in itself is an evidence of antiquity. Three or four species are found on both continents. Of several forms or species, we have yet little information, since they are known only from single or a few localities. A few species have also been found on the southern half of the globe—*V. costata* in Australia, *pulchella* in Australia and Mauritius; whether they are endemic there, or introduced by trade or plants, etc., it is impossible for us to decide at present, but the latter seems to be the more probable.

Of their station, we do not know enough to speak in a general way. They are mostly found under wood, stones, at the roots of plants, etc., and seem to be gregarious. They are frequent on mossy cliffs, and often in wet meadows, always, as it seems, more in open places than in deep forests. They are therefore likely to be washed off by heavy rains, and immense numbers of them, especially dead shells, are carried to the water courses and then found in the fine drift—always a matter of importance in collecting shells.

The materials upon which the present paper was written, are: the Drawer series of *Vallonia* in the collection of the Academy of Natural Sciences of Philadelphia ("Acad. Coll."), about 35 lots, kindly communicated by Mr. Henry A. Pilsbry; the reserve series of the collection of the National Museum, of Washington, D. C., forwarded by the kindness of Mr. Wm. H. Dall, about fifty parcels, and my own collection, now about 100 vials, comprising valuable contributions from MM. O. Staudinger and A. Bang-Haas, of Blasewitz, near Dresden, Germany. Several conchologists of this country, as already stated, were so kind as to collect and send, at my request, living examples of some of our American species.

SPECIAL DESCRIPTIONS.

Since the number of species has increased considerably in the last decades, they should be described as exactly as possible, especially in view of the above facts. Thus I think allowable the alteration of previous descriptions of several species, especially *V. pulchella* and *costata*, in some points which proved to be essential in exactly characterizing them; and there is no use in citing the older descriptions,¹¹ or in especially mentioning the changes made—the former are found elsewhere, and a comparison will show the latter at once.

In spite of some striking differences in the formation of the shell, it appears to be impossible to divide the species under well-defined subgenera or sections, as there are intermediate forms everywhere, and the anatomy, especially of the jaw and radula, furnishes no reason for doing so. An attempt, however, has been made to arrange them in natural groups, in the table after the special descriptions.

It might be thought useless to name many varieties; but this could hardly be avoided after careful study of the forms, and more of this has been done among larger mollusca.

Judging from Morse's and W. G. Binney's description of *Patula* (*Planogyra*) *asteriscus* Mse., I supposed this species might be a *Vallonia*. One specimen was not softened sufficiently to be examined thoroughly. The radula, however, showed the essential characters of *Vallonia*. Fresh specimens must be studied. Yet the finer surface structure of the shell is different from that of all true *Vallonia* I have seen: the nucleus is thickly set with minute pits somewhat elongated radially, and the post-embryonal whorls show microscopic revolving lines, as figured by Morse (*l. c.*). To judge from Morse's (*l. c.*) figure 51. p. 24, of the front part of the animal, this would also not agree with that of *Vallonia*.

V. pulchella Muller. Pl. VIII, fig. A, G, H, I, K, L. Man. Conch., Pl. 32, fig. 15.¹²

Hel. pulchella Müller, Verm. Hist., II, 1774, p. 30.

Hel. pulchella Auct.

Hel. paludosa Da Costa, 1780.

Hel. crystallina Dillwyn, 1817.

¹¹ It may be mentioned that they do not always agree among themselves, and that different forms have been comprised under one name and different characters regarded as essential or otherwise by various authors.

¹² Plates 32 and 33, referred to throughout this paper, will be found in Tryon and Pilsbry's Manual of Conchology (2), VIII.

- Hel. pulchella* var. *laevigata* Moq.-Tand., 1855, a. o.
Hel. minuta Say, Journ. Acad. Phila., 1817, p. 123.
Hel. minuta Say, Nichols. Enc., ed. 3, 1819.
Vallonia minuta Morse, Pulmonifera of Maine, 1864, p. 21 (part).
Vallonia minuta Tryon, Am. Journ. Conch., III, 1867, p. 36 (?).
Vallonia pulchella W. G. Binney, Terr. Moll. V., p. 344.
Vallonia pulchella W. G. Binney, Man. Am. Land Shells, 1885, p. 77.

Shell of medium size, first moderately, then for the last $\frac{1}{3}$ whorl widely umbilicated, convex or depressed conic above, pale horn or straw colored, transparent or milky opaque, finely and densely striate, somewhat stronger and rather regularly at the suture and the umbilicus, shining, smooth at the nucleus,¹³ whorls $3\frac{1}{3}$ –4, rather rapidly increasing, with a rather deep suture, the last comparatively large, well rounded, little expanded toward the aperture, not descending in front or slightly so at the suture; aperture moderately oblique and inclined, $\frac{5}{8}$ circular with umbilical margin a little more straight and slightly protracted; peristome decidedly and rather abruptly everted, with a strong, white lip, thinner at either end.

Diam. maj. 2.4, min. 2.0, alt. 1.2 mm.¹⁴

Soft parts as described above for the genus. The liver was found quite various in color: light yellow to lighter or darker brown, as has been noted above. The action of the heart also is described in the general description.

The jaw (Pl. VIII, figs. H, I, K, L) is rather strongly curved with obtuse ends, and no median projection on the cutting edge. The latter is more or less denticulated, irregularly, corresponding with the 18–25 variously coarse, rather sharp, longitudinal ribs irregularly distributed over the front plane of the jaw. For details see general description, p. 235. The width of the jaw was found to be 0.13–0.23, the height 0.065–0.07 mm.

The radula (Pl. VIII, figs. A, G) has 65–70 transverse rows of 27 teeth; it has already been said that Morse and W. G. Binney counted 23 and 21. There are three perfect laterals, with rather strong mesodonts, rapidly diminishing in size from the first to the third. The fourth and fifth make the transition, and at least the former is different from the true laterals only by the longer mesodont of the peculiar formation described above. In the fifth, which still has a well-formed though smaller plate, the mesodont is of the same char-

¹³ Yet, in a single specimen, I have seen few indistinct short lines.

¹⁴ The altitude given here, and for all the following species, is of the whole shell, since it is almost impossible to reliably measure in any other way.

acter as in the true marginals. Sometimes in the fourth, and even in the third tooth, the ectodont, though essentially simple, is finely double-pointed, and in the same longitudinal rows single- and double-pointed ectodonts may be seen irregularly alternating. The sixth, though a marginal in its configuration, still makes the transition, sometimes having an indication of a plate reaching beyond the reflection, and bearing only two outer cusps, rather short and a prolongation distal-ward with room for additional cusps, of which there is sometimes just a trace in the form of a very short blunt fourth one. The true marginals show 5-6 cusps, moderately long, in the 7th-9th, the mesial one being somewhat longer than the second, and slightly directed inward. The 12th tooth, like the following, is a fine transverse bar, only finely serrate, while the 13th or last, generally shows hardly a trace of cusps.

One example showed a peculiar feature of the radula: At the front end, for about 15 transverse rows, the cusps were worn off almost entirely by rasping, as usual (compare fig. G, Pl. VIII), but here the cusps of the last few rows were less so than the others. For this there can be no explanation but that after a period of comparative rest one of greater activity followed.

The following dimensions of the radula were found in several fresh individuals, as well as in those treated with alkali: length 0.68-0.71, width 0.24 mm.; length of transverse row about 0.01 mm.

A younger specimen, of about 1.5 mm. diam., had the radula with 60 transverse rows of 23 teeth, the first 3 on either side being perfect laterals, the fifth a marginal, with only 2 or 3 small distal cusps. The last 4 marginals are wide and thin transverse bars, with quite small cusps, the last with none at all.

The striation of the shell is somewhat unequal while quite fine and irregular over the most part of the whorls, it is stronger and rather regular at the umbilicus, and also at the suture; here the striae appear, under the microscope, like ribs, about 0.03-0.035 mm. apart.

Westerlund says in his diagnosis (*l. c.*) of the present species: "distinctly angular at the groove-like deepened suture." It made the same impression on me; but after examining numerous examples in different stages of growth, it was found that the whorls are equally rounded to the very suture, and that the apparent angle was an illusion caused by the reflection of the light.

Our species has a wide *geographical distribution*. It is found all over Europe, in Northern Africa,¹⁵ the Azores and Madeira, in at least Western and Northern Asia, and the greater part of North America. It seems to be absent or scarce in Eastern Asia, as well as on the Pacific slope of North America, and considering the relations of those faunas, this coincidence would not be surprising. From California, I have seen only specimens taken in a green-house at San José, and they may have been introduced there with plants. I can not remember having found a report of them from the Pacific coast, although *Vallonia* has been found on the Sierra Nevada. It has not been reported from some of the Gulf States. It has been reported from Florida, but Dall, in his paper on Florida land and fresh water mollusca, does not enumerate it. I have received several specimens lately from Mauritius, labeled as an unknown *Helix*. There are specimens from New South Wales, Australia, in the National Museum. As already said, they are probably introduced from Europe.

It must be borne in mind that many faunal reports, especially the older ones, should be received with reserve, since several species have been included under this name, which for a long time represented the entire genus. In collections, two or more different species are generally confounded. In our country the name *pulchella* was partly replaced by (*Helix*) *minuta* Say, the validity of which name will be found discussed under *V. excentrica*.

Our species has also been found fossil in the loess, etc., over a great part of both continents, often associated with *V. costata*, *tenuilabris* and probably other species.

It may be mentioned that about eighteen specimens from Pittsburgh, Pa., in the Academy's collection, are all darkened with a distinctly sooty coat, an effect of civilization upon snails!

V. pulchella is variable in size. While the average size is 2.4 mm. or rather less, the smallest specimens measure 2.0, the largest 2.7, but either extreme is exceptional, and I have seen none of 3 mm.¹⁶

¹⁵ Dr. W. Kobelt, in the report on his collecting trips in Tunis, Algeria and Morocco [Excursionen in Nordafrika, Nachrichtsbl. d. D. Mal. Ges., 1884-86, Eine Excursion nach Nord-Marocco, ibid. 1881, p. 149] does not mention this or any other species of *Vallonia*. They seem, consequently, to be at least scarce there.

¹⁶ The following are measurements of specimens from different localities:

	Average.	Largest.	Smallest.
Hermannstadt, Transylvania,.....	2.3	2.3	2.2
Montecchio, Italy.....	2.3	2.5	2.1
Sicily	2.3	2.4	2.2

Now and then one is found with a small shell, rapidly increasing last whorl and comparatively large aperture, strongly recalling similar examples of *Helix thyroides* Say. The whorls are, as a rule, $3\frac{1}{3}$ – $3\frac{1}{2}$ in number, and only the largest shells have 4 or nearly so. There is some variability in the size and shape of the umbilicus, being in some nearly as in *excentrica*, while in others it is almost regular or funnel-shaped; yet a marked widening near the aperture is almost always found.

It has been accepted as a character of *pulchella* that the last whorl does not descend at the aperture. This is only approximately true because while not in such a degree as in some other species, the last whorl descends distinctly, especially at the suture, in about one-third or one-fourth of the specimens from different places in Europe and North America. The last whorl, moreover, slightly ascends more at the back than at the suture, and specimens are even found with the last whorl first ascending and then descending slightly but distinctly at the suture, a character which is found more constant and more marked in *V. cyclophorella*, *tenuilabris* and others.

There is some variation also in the size and shape of the lip; it is almost typically stronger in the upper outer part, so as to modify the shape of the actual aperture, as shown in Man. Conch., Pl. 32, figs. 3 and 5, the same as in *V. costata*, fig. 22, and *pulchellula* Hde., fig. 53. In the upper part also the lip often protrudes beyond the margin, and specimens are not uncommon where the strong lip projects on the whole circumference, except at the ends (fig. 4). While fresh shells are usually of pale horn color and transparent, some may be found whitish or milky opaque. I found a colony of about a hundred exclusively so colored some years ago, in

	Average.	Largest.	Smallest.
Aargau, Switzerl. (drift).....	2.3	2.5	2.1
Lyons, France (the largest).....	2.5	2.7	2.3
Madeira.....	2.4	2.5	2.3
Washington, D. C.....	2.3	2.4	2.2
Saco, Maine (2 examples. only).....	2.2	2.2	2.2
Quebec, Canada.....	2.3	2.4	2.1
Brantford, Ontario.....	2.4	2.5	2.2
Tremont, Pa.....	2.4	2.6	2.2
New Philadelphia, Ohio.....	2.3	2.6	2.1
Joliet, Ill.....	2.4	2.5	2.0
Iowa City, Iowa.....	2.4	2.6	2.2
Greenville, Tenn.....	2.3	2.4	2.1
San José, Cal. (greenhouse).....	2.3	2.4	2.1
Mauritius.....	2.3	2.4	2.3

a garden of New Philadelphia, all living, while at other places in and around the city they were of the ordinary appearance. I have seen the same form from other localities, yet it seems not to represent a true variety.

V. pulchella may be mistaken, when young or immature, for *Hyal. minuscula* Binn., in North America only, having the same lipless, glassy shell and the same color of the soft parts. Yet the somewhat experienced collector will know the latter by the comparatively smaller, more gradually increasing (and so more numerous) whorls, the generally stronger striation and the umbilicus being wider from beginning. On the Old Continent, there is no land snail, as far as I know, which our species closely resembles, even when immature, except other species of *Vallonia*.

V. pulchella var. *enniensis* Gredl. Tirol's Conchylien, 1856.

A form with strong, rib-like striæ, but without membranous ribs. It has been found in Tirol, at Neumarkt, Hall and Botzen. I found two specimens, evidently of this form mixed in a lot of *V. costata* from Grasse, France (Acad. Coll.). The striæ are very strong, but the other characters of the shell are those of *V. pulchella*.

V. pulchella var. *hispanica*, n.

Shell small, diam. maj. 2.0–2.3, averaging 2.1, pale horn colored or whitish; whorls 3–3½, the last little predominating, somewhat expanding toward the aperture; the latter $\frac{5}{8}$ circular; peristome moderately everted, with a moderately strong lip, little or not thinner at the ends; spire little elevated, in some examples almost flat; umbilicus as in typical *pulchella*; surface strongly, rather regularly striate, rather ribbed (ribs without membranes); nucleus with rather strong revolving lines. Spain (no special habitat), ten specimens in the Nat. Mus. Coll. Anatomical examination would be very desirable and possibly might show the form to be a distinct species. Resembles the preceding variety.

V. pulchella var. *persica* Rosen. Nachrichtsbl. D. Mal. Ges. 1892, p. 123.¹⁷

Differs from the type by the last whorl descending to the aperture, with a flat [*plano*], widely expanded peristome. Hab. Schamhala, Prov. Chorassan, Persia.

I have seen no specimens, but think this might be a form distinct from *pulchella*.

¹⁷ Beiträge zur Kenntniss der Molluskenfauna Transkasiens und Chorassans, von Baron Otto Rosen, Ashabad.

2. *V. excentrica* n. sp., Pl. VIII, fig. B, M. Man. Conch., Pl. 32, figs. 6-9.

Vallonia minuta Say, Morse, Pulmonif. Me., p. 21 (part.).

Shell of medium size, with maj. diam. markedly longer, and with irregular, somewhat elongated umbilicus at first rather narrow, then for the last $\frac{1}{2}$ whorl rapidly widening; slightly rounded convex above, smooth or very finely and irregularly striate, strongly and regularly at the umbilicus; nucleus smooth; pale horn colored, transparent or slightly opaque, with a somewhat fatty gloss; whorls 3-3 $\frac{1}{2}$, rather rapidly increasing with a moderately deep suture, the last comparatively large, well rounded, expanding near the aperture, not descending, or very little at the suture; aperture moderately oblique and inclined, $\frac{5}{8}$ circular, subangular at the base; the umbilical margin somewhat protracted; peristome not everted above, very little at the periphery and moderately below, with a rather strong white lip, thinner at the ends, visible through the shell.

Diam. maj. 2.3, min. 1.8, alt. 1.1 mm.

I was enabled to see the soft parts in a few specimens from Quebec, kindly forwarded by Mr. H. W. Hanham. The foot is, compared with that of *costata*, a little less transparent and of a slight yellowish tinge, as is also that of *pulchella*. But this difference of tint is perceptible only when the animals are side by side. The *jaw* (Pl. VIII, fig. M) is moderately curved above; the cutting edge with a slight, wide median projection and almost straight side parts; the ends are rounded. The front bears rather fine, dense, sharp, slightly irregular ribs, all over. Size of jaw 0.08 mm. high, 0.28 wide, when depressed.

The radula (Pl. VIII, fig. B) has 81-84 transverse rows of 29 teeth. There are four perfect laterals; the fifth marks the transition; it distinctly shows the peculiar formation of the mesodont, has smaller though well-formed plate of attachment, and two small distal cusps, the ectodont being already split. The sixth is a marginal but still marks the transition: it is triangular, with 3-4 cusps. With the exception of the last 1 or 2 which are hardly serrate, the marginals are pectinate with 5-7 cusps, and the 7th-10th are placed in a peculiar way, as at least the 3-4 mesial cusps are standing on a common socle. The radula is 0.79 mm. long., 0.29 wide; one transverse row measures, as usual, nearly 0.01 mm.

The animal seems to be somewhat less lively and more timid than *V. costata*.

The *geographic distribution* is a wide one—all Europe and the Atlantic side of North America. I have seen it from the Pyrenees; France: Lyons, among a lot of *pulchella*; collected by Locard; Great Britain (no loc., in Nat. Mus. Coll.); Germany: Metz, Dresden and Neu Haldensleben in Saxony; Austro-Hungary: Brosteni in the Karpathian Mts.; Switzerland: Jura Mts. near Brugg; Caucasus. In North America: Washington, D. C., with *pulchella*; New Jersey: Princeton, Cape May, etc.; Pennsylvania: near Philadelphia; New York: Staten Id., Litchfield, Mohawk and other places; Massachusetts: New Bedford, etc.; Maine: Saco, Cape Elizabeth, etc.; Halifax, N. S. and Quebec in Canada; Ohio; New Philadelphia, not found in loco, but in drift on the Tuscarawas River. Further west it has not been noticed, so far. Among numerous lots of *V. pulchella* from Indiana, Illinois, Michigan, Wisconsin, Iowa, Tennessee and other States, I have not seen one example.

It is distinguished from the last-named species by its size, averaging a little smaller, by the somewhat elongated outline of shell and umbilicus, the last whorl more expanding toward the aperture, the smaller and less elevated spire, the less deep suture, the peristome little and not abruptly everted; the difference in this is most marked at the periphery (as clearly shown in fig. 9, compared with 2). There are also differences in the jaw and radula, as pointed out in the respective descriptions. One marked characteristic of *V. excentrica* is the white lip shining through the shell above and at the periphery, as it does in no other species.

There is another peculiar feature: quite frequently, especially from certain places, there are very small, whitish dots on the surface of the shell, round, or irregularly shaped, single or confluent. They are effected by the loss of the epiconch and evidently indicate a change in the structure of the shell and may be caused by the invasion of a fungus organism. This is the more probable as over many of the spots, especially those less marked and noticeable, the epiconch is apparently intact; probably they would show only microscopic defects. These abrasions often become so extended as to cover a great part of the surface.

Our species is variable only within narrow limits. The size varies little above or below the average. Some specimens and local forms show less of that characteristic elongate outline of shell and umbilicus, and yet are not to be mistaken. There is also some

variability in the transparency of the shell—the New York and New England specimens are, as a rule, more glassy and shining than those from Washington, D. C. and from Europe.

In a lot of *Vallonia* from the Pyrenees (no special habitat or region is noted), belonging to the Academy Collection, there was one poor weathered specimen of *V. pulchella* and a number of *V. costata*, together with a peculiar variety, and the present form, which then struck me for the first time as probably being a distinct species.

At Washington, D. C., I collected in February and again in March, 1889, under granite stones, numerous *Vallonia* which then were simply placed as *pulchella*. Many of those collected there in March, under bricks in an old brick-yard were in company with *Hyalinia minuscula* Binn., and *Pupa procera* Gould, of which, it may be mentioned, I secured about 800 specimens in a few hours by brushing the bricks. When I began to study *Vallonia* specially, these shells were looked over carefully,¹⁸ and then I was surprised to find both species, *pulchella* and the one under consideration, in both of the two former lots, while those from the brick-yard were *pulchella* exclusively. They were so exactly like the Pyrenean shells that there could not be the least doubt as to their identity; they were so distinct from *pulchella* as to be separated one by one at first glance, there being no doubtful or intermediate examples. Subsequently I looked over every specimen of more than 90 parcels of *Vallonia* containing either *pulchella* or the new form, or both, coming from Europe and North America, and the result was to establish the certainty that the present is a good species, for which I propose the name *V. excentrica*. It is of a wide geographical distribution, its shell being readily discerned when once attention has been directed to its peculiarities. But it must be added that specimens are found occasionally in which the distinction is somewhat obscure; these are generally small *pulchella* which had been damaged and restored more or less imperfectly, with little everted peristome. I have several such examples: one from Illinois which, at first sight, would be taken for *excentrica*, but by close examination proves to be *pulchella*. On the other hand, one example of *V. excentrica*, from Washington, D. C., has a rather strongly everted lip, caused by a breakage near the aperture.

It is somewhat surprising that this form has been overlooked in

¹⁸ As I have sent specimens to several conchologists, they should now be revised.

Europe, being taken for *pulchella*. In North America we meet the old question of the validity of *V. (Hel.) minuta* Say. When Say described this species, "he was probably unacquainted with *Vallonia pulchella* of Europe, as he makes no remarks on the resemblance of this species to the European form," as Morse (*l. c.*) justly remarks, continuing: "Stimpson, Kirtland, and De Kay retain the specific name of *minuta* for this shell, while Binney, Gould, W. G. Binney, Adams, Mighels and all the European writers unite it with *pulchella*."

Among writers since Morse's publication, opinion is still divided. Say's description (*l. c.*) is as follows: "Shell rather thick; spire convex, little elevated, with three volutions; suture well-defined, impressed; whorls obtusely wrinkled across; aperture nearly orbicular; lip much thickened, reflected, white, distant from the umbilicus; umbilicus large, exhibiting the volutions. Breadth less than one-tenth of an inch." The description decidedly points to *pulchella* in nearly every particular and can not be applied to *excentrica*. Say, himself, however, later acknowledged the identity of his *minuta* with *pulchella*,¹⁹ and these are reasons enough for not applying this name to a species distinct from *pulchella*.

Morse (*l. c.*) expresses the opinion that the American shell, *minuta*, is distinct from the European, *pulchella*, and proves it, mainly from the shape of the aperture and the angle formed by the latter with the axis of the shell, the American form being more translucent, and the epiconch somewhat different.

J. W. Thomson²⁰ refers only to *V. minuta*, and adds: "I cannot consider this species to equal *H. pulchella* Müll." It certainly is probable that Morse had our *V. excentrica* before him, as it, as well as *pulchella*, is frequent in Maine, but it is surprising that he did not speak of other differences, especially the peculiar shape of the umbilicus, the outline of the whole shell, and the fact that the peristome is very little everted in comparison with *pulchella*. The transparency of the shell differs in each species, and I have seen *excentrica* rather more opaque than usual in *pulchella*. The form of the upper part of the aperture is also variable in *pulchella* as well as in *excentrica*, especially in the suture slightly descending to the aperture in many specimens, while in others it does not. The difference in the inclination of the aperture I have not found so constant and

¹⁹ See W. G. Binney, Terr. Moll. IV, p. 69.

²⁰ The Land Mollusca of Bristol Co., Mass., Journ. Conch., 1885, p. 372.

marked after comparing numerous specimens from many localities on both continents.

Morse also speaks of differences in the lingual dentition and buccal plate (jaw) between *minuta* and *pulchella*, but it seems not from his own observations; and it must be said that his description and figure²¹ of the radula seem rather to be drawn from *pulchella* than from what we consider *excentrica*. The latter has the formula 14-1-14, or 29 in a transverse row against 23-1-23 in *pulchella*. I would have drawn the marginals (or uncini, as he calls them) differently, had he then really had *excentrica* before him. Since the two species live together along the Atlantic coast, it is probable that they were mixed, as is the case in nearly every lot coming from the coast from Maryland to Nova Scotia. The mistake was very likely to occur, even in the case of such a careful observer as Morse.

W. G. Binney,²² as well as other writers, is of the opinion that there is only one species, *pulchella*, and his own description as well as figures represent the same. Evidently he examined only examples of the species referred to.

Has *V. excentrica* been introduced from Europe? It is found only in the East, in the oldest settled parts of the country, where also several European Limaces are common. But the latter live almost exclusively in and about dwellings, while *Vallonia* seems to be spread all over the region. Thus it may be considered native here as well as *V. pulchella* and *costata*.

3. *V. adela* Westerlund.

Hel. adela Westerlund, Ofversigt af K. Vet. Ak. Forh., 1881, 4, p. 37.

Hel. adela Westerlund, Fauna der in der Palaearktischen Region lebenden Binnenconchylien, I, Berlin, 1889, p. 14.

"Shell openly umbilicated, depressed trochiform or convex, very indistinctly, finely striate or smooth, whitish; whorls 4-4½, rather convex, not at all angular at the rather deep suture, rather rapidly increasing, the last comparatively large, rounded, not expanded, not descending in front; aperture crescentic-circular, with margins separated, peristome very narrowly everted or almost straight and without a lip. Size 2½ to 3: 1½ to 1¾ mm. (Suabian Alps; fossil in a sub-marine peat-bog, near Ystad, in southern Sweden.)"

The above description is translated from West. Fauna, *l. c.* I have seen no specimens. Two examples, in a vial, with the label:

²¹ L. c., p. 21, fig. 57, Pl. 8.

²² L. c. and Invertebrata of Mass. ed. II, p. 428. The outlines of the upper figure in the latter rather strongly resemble those of *V. costata*; generally the umbilicus is not as regular as shown in the lower figures of either work.

"*Vallonia adela* West., Ystad; ex auctore," kindly forwarded by Mr. Pilsbry, are evidently incorrectly named. One of them is *V. pulchella* with rather elevated spire, and a well-formed lip; the other *costata* with (for the species) also an elevated spire and strongly descending last whorl.

The species has not been figured.

3a. *V. declivis* (?) n. sp. Man. Conch., Pl. 32, fig. 10-13.

Shell of medium size, depressed conic, widely and regularly umbilicated, whitish, transparent, surface with fine, dense striæ, nucleus smooth; whorls 4, gradually increasing, with a rather deep suture, the last well-rounded, not predominating, slightly expanding toward the aperture and gradually descending in its last third to the periphery of the penultimate whorl or rather below it; aperture moderately inclined and oblique, nearly $\frac{3}{4}$ crescentic-circular, the inferior end of margin slightly protracted; peristome straight above, and very narrowly everted at the periphery and the inferior part, with a thin but distinct lip.

Diam. maj. 2.6, min. 2.4, alt. 1.4 mm.

Soft parts not seen.

Distribution: Central Europe. I received, about 12 years ago, from Mr. S. Clessin, as *Hel. tenuilabris* Braun, 3 examples from the drift on the Danube River, in Bavaria. Although dead shells, they are fresh and well-preserved, and all exactly alike. I found another specimen in drift on the Aar River, in Switzerland, also in good condition, and of the same size and shape as those from the Danube, except that it has no lip, and the margin is simple and straight; it may not, however, be mature.

This form is evidently not *V. tenuilabris* of A. Braun, as it does not correspond at all in several different points, with the description of that species, nor any other known to me. It would, consequently, not be amiss to propose a specific name for it.

It is not "densely and acutely, finely ribbed," but very finely striate, appearing almost smooth and shining; the peristome is not everted, or very narrowly and indistinctly so, while in *tenuilabris* it is "widened" (which evidently means everted) and the inferior margin reflexed; the aperture is not "transversely oval-rounded," and not "very oblique," and the margins are not "very approximate," but, for a *Vallonia*, markedly distant; the shell is not "grayish-horn with peristome yellowish horn colored," but whitish transparent throughout.

It differs from *V. pulchella* in its somewhat larger size, the wider and more regular umbilicus, the whorls being $\frac{1}{2}$ more in number and more slowly increasing, the last comparatively narrower, gradually descending entirely to the aperture, and the peristome being straight or just perceptibly everted with a much thinner lip.

V. declivis var. *altis*, nov. Man. Conch., Pl. 32, fig. 14-17.

This form differs from the above in its somewhat larger size, narrower and deeper umbilicus, more elevated spire, the last whorl descending below the circumference of the penultimate; the peristome being quite straight and thin, without a lip; the aperture is very little oblique, in fact, the least so of all the *Vallonia* I know, and moderately inclined, rather higher than wide, subangular inward at the base; whorls $4\frac{1}{2}$; the color is whitish, the surface densely, rather regularly striate.

Diam. maj. 2.9 min. 2.5, alt. 1.7 mm.

This form might represent a species, but, from its similarity to *declivis*, and the few examples known, I prefer, for the present, to regard it as a variety.

I found one specimen in 1882, also in drift on the Aar River, Switzerland. Another has been kindly forwarded by Mr. Pilsbry, it is from drift on the Main River, in Middle Germany, and bears also the name *H. tenuilabris* Braun. They are exactly alike.

I found, in 1882, while in Switzerland, among drift shells from the Doubs River, on the western slope of the Jura Mountains, a few specimens of either *declivis* or *altis*, having then labeled them also *H. tenuilabris* A. Br.

All the examples of this species extant, though dead shells and found in drift, are fresh and in good condition, and it is to be expected that living specimens will be found in those countries. If a new species has been established on the few specimens, it is because they could not reasonably be brought under one of those already known without modifying their diagnoses so that they would have been valueless.

I believed for a time that this might be the *V. adela* of Westerlund, judging from the description. But the author says expressly that the last whorl does not descend at all,²³ while in the forms under consideration this is just the prominent feature. Since I failed to

²³ Conf. Westerlund Fauna, I Suppl. 1890, p. 120, *H. tenuilabris* var. under *V. mionecton* Bttg., also cited below, No. 14.

obtain authentic specimens of *adela*, some doubt in regard to this question will yet remain.

4. *V. pollinensis* Paulucci.

Hel. pollinensis in Westerlund, Fauna, I Suppl., p. 120.

Shell with a rather narrow, funnel-shaped umbilicus (the same at the aperture, little and gradually widening), convex, with obtuse, prominent apex, light horn colored, exceedingly finely striate, adorned with more distant, acute, lamelliform, regular fine ribs; whorls $4\frac{1}{2}$, regularly increasing, convex, with impressed suture, the last gradually increasing and not at all expanded at the aperture, rather constricted, scarcely wider than the penultimate, slightly, and gradually descending above; aperture little oblique, crescentic-circular, descending [?], margin straight, simple; only the columellar margin somewhat everted high up. Size $2\frac{1}{2}$ by $1\frac{1}{2}$ m. (Italy, Monte Pollina in Prov. Potenza: Paul. ex.) Not figured.

Translated from Westerlund, *l. c.*

I have seen no specimens. To judge from the description, it seems to be a somewhat intermediate form between the above species and the costate groups.

5. *V. costata* Muller, Pl. VIII, figs. C, N. Man. Conch., Pl. 32, figs. 18-22, 27, Pl. 33, fig. 54.

Helix costata Müller, Verm. Hist., II, 1774, p. 31.

Helix costata Rossm. Icon., 439.

Helix costata Dupuy, Hist. 1848, p. 162, T. 7, fig. 4.

Helix costata Westerlund Fauna, I, p. 14—a. o.

Helix pulchella var. *costata* of most authors.

Vallonia rosalia Risso, 1826 (ex. West. *l. c.*).

Shell with a moderate umbilicus more widening for the last $\frac{1}{3}$ — $\frac{1}{2}$ whorl, depressed convex above (or nearly flat), grayish to light or reddish horn colored, with rather regularly set membranous ribs and irregular microscopic striæ between them; nucleus with fine revolving lines; whorls $3\frac{1}{2}$, slightly flattened above and below the periphery, at the latter somewhat angular, with a deep suture, rather rapidly increasing; the last expanding near the aperture and shortly descending, more so at the suture than on the back; aperture rather inclined and oblique, almost circular, a little flattened above and angular at the base, with ends of margin much approximate, slightly protracted and auricled, connected by a thin callus; peristome strongly and abruptly everted, except near the suture, with a strong, white lip evanescent at either end.

Diam. maj. 2·5, min. 2·1, alt. 1·1 mm.

Soft parts: the foot is about as long as the diameter of the shell, quite transparent, a little more so than in *V. pulchella* and *excentrica*. The jaw, Pl. VIII, fig. N, is rather strongly curved moderately high, stout, chestnut colored in the inferior part, with 16-18 rather strong ribs on the front side, leaving about $\frac{1}{3}$ of either side at the end ribless and smooth. The cutting edge is denticulated, and sometimes appears a little more straight in the median part, but there is no projection. The lines of growth are distinctly visible. Width of jaw 0.25, height 0.088 mm.

The radula has 69-72 transverse rows of 27 (or 29) teeth. In the central the side cusps are very small, barely perceptible, and the side margins of the plate are curved up in nearly their entire length. There are 4 perfect laterals with the mesodont comparatively thin, the ectodont very small, scarcely half the size of the same in *V. excentrica*. The fifth makes the transition, but resembles rather the laterals, having a well-formed plate of attachment with a projecting posterior distal angle. Its mesodont shows an indication of its transformation and the ectodont is essentially simple, but, at least in some parts, with two points. The sixth or first marginal is somewhat triangular, and with a distinctly backward extended plate of attachment, and the reflection with 2 or 3 short distal cusps, as it is still in the following or seventh tooth. On the other marginals the cusps are comparatively small and stand immediately up on the bases. Length of the radula 0.71, width 0.22-0.23 mm.

V. costata is distributed over a wide geographical area, being found all over Europe, Northern Africa, and the most part of Asia. In North America it seems to occupy a wide area also, though it is not as common as *V. pulchella*. It has been cited from Philadelphia and Cincinnati. I have seen it from Washington, D. C., from Quebec, Canada, and Isle d'Orleans, near that city, collected by Mr. A. W. Hanham, also from Iowa, Nebraska, Kansas and Colorado. All reports of distribution must be received with reserve, and especially those from high altitudes in western North America, as under the name of *costata* doubtless different forms are comprised, such as *gracilicosta*, *parvula*, *cyclophorella* and others. It has also been found in Australia, by Cox, as reported by Brazier (Journ. Conch., 1879).*

Until recently, and even now, *V. costata* has been considered a variety of *pulchella*. The characters of the shell, decidedly and

* See Appendix.

constantly different from those of that species, prove it to be altogether distinct. One of the main distinguishing features is the presence of very fine, raised revolving lines on the nucleus, or the $1\frac{1}{2}$ embryonal whorls, while those of *V. pulchella* are smooth. The generally much more depressed spire, the deeper suture beside the rather flatter whorls above, the last whorl more rapidly expanding toward and descending to the aperture, especially at the suture, the more approximate margins rendering the aperture nearly circular, are sufficient to distinguish *costata* from *pulchella*, even in the absence of the membranous ribs, the most striking character of the average shell.

Our species, however, has these ribs and most of the other characters in common with several other forms, mostly found in Asia and North America, while in Europe *V. costata* seems to be more isolated. On the other hand, several of those related species seem to be intermediate between this and the *tenuilabris-cyclophorella*, etc., groups. All these forms need much more careful study.

When seen under the microscope, the epiconch ("epidermis") shows between the membranous ribs, 4-6 finer raised striæ, and, in addition, very numerous microscopic lines in a general radial direction, but mostly intercrossing in various ways, except near the suture where usually they are parallel (Man. Conch., Pl. 32, figs. 27, 28.)

V. costata is quite variable, and a number of extreme forms must be regarded as varieties. It may even prove to be difficult to draw a line between this species and some others nearly related. In size it averages 2.5 mm., few specimens measuring 2.7 or more, and the smallest are 2.1-2.2. The number of whorls is almost constantly $3\frac{1}{2}$, hardly more in the largest examples, and somewhat over 3 in the smallest. There is variation also in the elevation of the spire—in many specimens it is almost or quite flat and very low in the average. In those from Quebec, Canada, it is comparatively elevated. As to the descending of the last whorl, it must be repeated that the suture always descends more decidedly than the whorl in its totality, and specimens are not scarce in which the back of the whorl keeps nearly or exactly horizontal to the very margin, as in *V. parvula* (Man. Conch. fig. 25, Pl. 32). Some diversity is also found in the size and closeness, or number of the ribs: I counted from 23-35 on the last whorl in different specimens which may be regarded as typical. The lip also is variable, but always rather strong, and

specimens with a thin or wanting lip are likely to be either immature or erroneously identified. Occasionally the lip protrudes strongly with a sharp edge, beyond the level of the aperture, as it occurs also in *V. pulchella*.

The following forms are more distinct, and must be regarded as varieties:

***V. costata* var. *helvetica*, n.**

Shell small, colorless, glassy-transparent, shining, with rather regularly set, stronger (yet fine) striae, but without membranous ribs; umbilicus regularly spiral; diameter averaging 2.2 mm.

This is a very peculiar and beautiful *Vallonia*. It might be taken for a different species or for *pulchella*, but the deeper and, at the aperture, descending suture, the more approximate margins, and the regular though very fine rib-striae, range it near *costata*. Those striae are perceptible rather more by their being whitish in the glassy shell than by their size.

The originals were collected in 1882 on the Geissberg, Jura Mountains, near Brugg, Switzerland, by Dr. R. Haeusler. After the description, it is hardly necessary to add that they were quite fresh, not weathered; the epiconch, though very thin, was not wanting. In drift on the Aar River, then being in the Jura range, I found some more specimens the same year, together with *V. pulchella*, *declivis*, typical *costata*, and intermediate specimens between the latter and the present variety.

***V. costata* var. *amurensis*, n. Man. Conch., Pl. 33, figs. 50-52.**

Shell small; umbilicus rather regular, wide perspective from the first volutions; spire nearly flat; ribs strong and distant, about 22 on the last volution; last whorl very little or not at all descending on the back; color deep horn; diameter 2.2 mm.

The specimens are from Kassakewitsch on the Amur (Northeastern Asia) and were kindly forwarded by MM. O. Staudinger and A. Bang-Haas.

***V. costata* var. *pyrenaica*, n.**

Shell large; umbilicus wide, perspective rather regular; whorls 4, more gradually and regularly increasing than in the type, the last less expanding at the aperture, moderately or not at all descending in toto; ribs small, hardly membranous. The outline is somewhat peculiar: there is a slight angle in the circumference of the last whorl about $\frac{1}{5}$ volution above the aperture, much as in *V.*

cyclophorella (Man. Conch., Pl. 33, fig. 30). Diam. 2·6–2·8 mm. It is a form decidedly different from the type, but, as it seems, connected by intermediate specimens.

Pyrenees (Acad. Coll.; see under *V. perspectiva*, p. 271).

V. costata var. **montana**, n.

Shell rather small and thick, colorless translucent, a little opaque, spire a little elevated; surface with rather crowded rib-striæ, but without membranous ribs; last whorl slightly and gradually ascending, not at all or very little descending to the aperture in toto, shortly and decidedly at the suture; lip very strong.

There are two specimens, not quite fresh, in the Acad. Coll., marked "*H. minuta* Say, Rocky Mts., E. Hall," with the above characteristics. They cannot be ranged under typical *costata*, yet they have the general appearance of that species, so that they may be placed as a variety under it until more and better specimens are obtained.

6. **V. albula** n. sp., Pl. VIII, figs. D and O. Man. Conch. Pl. 33, figs. 48, 49.

About the middle of Nov., 1892, Mr. A. W. Hanham sent me a third lot of fresh *Vallonia* from St. Joseph, Quebec,²⁴ Canada. Among them were four beautiful examples, three of them living, which I first somewhat doubtfully referred to *V. gracilicosta*. After repeated comparison I find that they differ essentially from this species. I cannot, with certainty, range them under any other.

The shell is rather large, 2·7–2·8 mm. gr. diam., whitish translucent, with a somewhat elevated spire; whorls 3½–4; the last whorl and aperture are rather well rounded, the latter resembling that of *costata*. The lip is moderately strong. The ribs of the shell are distinct but small, crowded, about 55 on the last whorl, and bearing fine membranes which give the surface a beautiful silky gloss as in some *cyclophorella*. There are differences in the elevation of the spire and the ascending of the last whorl among the four specimens, as is the case in most other forms.

In outer aspect the soft parts are much like those of other species. The liver is pale yellowish or horn colored. The jaw and especially the radula show some peculiarities, both being comparatively large. The jaw is 0·31 mm. wide, of pale horn color, and appears some-

²⁴ Mr. Hanham's assiduous collecting brought to our knowledge four different *Vallonia* from the vicinity of Quebec: *pulchella*, *excentrica*, *costata*, and the one under consideration.

what thin and flexible, with rather crowded, strong, irregular rib-striæ, evanescent toward the upper and strongly denticulating the cutting edge; the posterior duplicature appears also rather thin and soft; Pl. VIII, fig. O, shows it extended by pressure.

I could not measure exactly the length of the radula nor count the transverse rows in the specimen examined; it is 0.27 mm. wide. Formula R: $4+2:10$ (11); there are, consequently, 33 (35) teeth, the highest number seen in a *Vallonia*. The central tooth is of common shape, rather wide but not much wider posteriorly, its lateral edges curved up for the most part of their length. On the 4 perfect laterals the cusps are stout; the fifth and sixth are transition teeth having a smaller though distinct plate, but with hardly projecting posterior distal angle. Their mesodonts are marked of the formation pointed out in the general description, while the ectodonts are simple in most, finely two-pointed in some interspersed teeth. Of all laterals the ectodonts are larger than the same in *V. costata*. The marginals are as usual, but with comparatively few cusps. The seventh tooth from the center is a true marginal in its whole configuration, though with only 2-3 short distal cusps; here the transition from laterals to marginals is more abrupt than in any other species seen. The last marginals (1-2) are quite small and with hardly any perceptible cusps.

The shell is related on one side to *costata*, on the other to *cyclophorella*, and seems to be intermediate. It resembles the latter in its size and general appearance, the umbilicus being rather wide and considerably expanding for the last $\frac{1}{2}$ whorl, the latter distinctly ascending before descending; in the fine dense ribs, which are stronger and sharper on the shell itself and bear smaller membranes than in *costata* and in the coloration. It has, however, some features allying it to *costata*—the aperture although less transversely elongated, is not circular. The presence of a lip is characteristic, and the peristome is rather abruptly and strongly everted, as in *costata*. These characters, together with the formation of the jaw and radula place this *Vallonia* in a peculiar position. I regard it as a distinct species, for which I propose the name *albula*, because of its whitish shell.

Mr. Geo. W. Taylor, of Victoria, B. C., sent me recently a few *Vallonia* for examination, among which there was one specimen from the Rocky Mountains, B. C., resembling in size and shape the Quebec specimens, although it was weathered and had lost its epi-

conch. Two examples, in the same condition, from Winnipeg, Manitoba, are related to these, but are somewhat smaller, and resemble *V. costata*. *V. albula*, therefore, seems to be widely distributed over the northern part of our Continent, and more specimens will probably be found in that region.

7. *V. parvula*, n. sp.,²⁵ Pl. VIII, fig. R. Man. Conch., Pl. 32, figs. 23-26, 28.

Shell small, widely umbilicated, especially for the last $\frac{3}{4}$ - $\frac{1}{2}$ whorl, quite flat above or with very little prominent apex, thin, horn-colored to nearly colorless, with rather fine, dense, membranous ribs (about 30-38 on the last whorl), and microscopic, intercrossing lines between them; nucleus with fine revolving lines; whorls a little over 3, slightly flattened above and below the periphery, with a deep suture: the last much wider than the penultimate, rather rapidly expanding toward the aperture and descending only at the suture in front; aperture very oblique, tangential and rather inclined, almost circular with ends of margin much approximate; peristome with a rather strong, pale horn colored lip. Diam. maj. 2.0, min. 1.6, alt. about 0.8 mm.

I was enabled to examine the soft parts through the kindness of Mr. Jas. H. Ferriss.²⁶ The jaw is rather strongly curved, of about the same configuration as that of *V. costata* (Pl. VIII, fig. N), stout, of chestnut color, with about 18 strong, coarse ribs, strongly denticulating the cutting edge. They are of the formation described above (Pl. VIII, fig. R). The side ends show hardly a trace of ribs and appear smooth.

I counted about 67 transverse rows of 23 teeth on the radula. There are 3 perfect laterals, and the fourth may well range with them, being very little modified by a somewhat small plate of attachment, the mesodont being nearly normal and the ectodont still simple but two-pointed in most teeth. The fifth is formed like the marginals, but the 2-3 distal cusps are very small and short. Thus the transition is more rapid here than in any other species. There are 4 well-formed marginals, with 4-5 comparatively short cusps; the tenth tooth bears hardly any perceptible cusps, and the eleventh (last) not a trace of such. Pl. VIII, fig. P, shows a central tooth in half profile with the strong and cusp-like prominent posterior angles of

²⁵ See notice in *Nautilus*, V, No. 3, p. 100.

²⁶ Who, upon my request to send living specimens, not finding any at Joliet, made a trip of 8 miles in the worst of weather to secure them.

the plate of attachment. A radula was 0.58 mm. long, 0.2 wide, thus one transverse row measures about 0.009 mm. in length.

The ganglia are described above.

This is a North American species, occurring apparently almost exclusively in the prairie States. I have seen specimens from Joliet and Ottawa, Illinois; Davenport and Bonair, Iowa; numerous examples in drift on the Missouri River, collected at Eastport, Iowa, together with *V. costata* and a few *perspectiva*; Nebraska; Wichita, Kansas; Indian Territory. Doubtless many of them are in collections under the name *costata*, etc.

V. parvula much resembles *costata*, but it is decidedly and constantly smaller, having scarcely half the bulk of the latter, and distinguished by the comparatively wider umbilicus and by the last whorl not descending, the peristome, as a rule, being quite straight on the back to margin, as shown in Man. Conch., Pl. 32, fig. 25. Sometimes it is gradually and slightly ascending, as in *V. costata*, *pulchella*, *excentrica*. Never have I seen a doubtful specimen between *parvula* and *costata*, and they inhabit the same region. Our species also resemble *perspectiva* in color, size and presence of the ribs; the differences will be pointed out in connection with the latter species.

V. parvula shows a little variation. The average size is scarcely 2.0 mm.; one is found with 2.1, but some are as small as 1.7. The lip is almost always comparatively strong, and the aperture always rather circular, sometimes as shown in fig. 26. One specimen from Bird's Bridge, Will County, Illinois, among about eight which I owe to the kindness of Mr. Ferriss, has the last whorl descending, the peristome continuous and free from the penultimate, thus resembling *V. perspectiva*; but the strong lip and the rather circular, not transversely elongate aperture characterize it as *parvula*. The abnormality may be caused by a breakage, as in other species.

For a time I regarded this *Vallonia* as *americana* of Ancy (ms.) Mr. Theo. D. A. Cockerell kindly furnished me a copy of Ancy's ms. description which I communicate here: *V. americana* differs from *cyclophorella* by its "taille plus faible, son ombilic très-grand aussi [?] et fortement dilaté au dernier tour, ses tours à croissance plus rapide, et en nombre moindre (3½ seulement) son dernier tour nullement descendant, plus ample à sa terminaison, son péristome fortement épaissi, son ouverture à bords distants et beaucoup plus grand," etc. From *costata* it differs "par l'ampleur de son dernier

tour vers l'ouverture, le caractère de son ombilic qui est aussi un peu plus grand ; la croissance plus rapide des tours qui sont un peu moins nombreux, enfin par sa taille plus faible." The size is not given.

This description would fairly well correspond with *V. parvula*, but for one point. Ancey says: "son ouverture à bords distant," while in our species they are much approximate, even more so than in *costata* and in *cyclophorella*. We can hardly understand how Ancey would characterize *V. americana* by comparing it with *cyclophorella* if it were the present species, since the two are very different. There is no description of the color or the structure of the surface. I did not succeed in procuring specimens for comparison.

There is a note in Mr. Cockerell's letter worth communicating: "*costata* var. *minor*—very small, diam. $1\frac{1}{2}$ – $1\frac{3}{4}$ mm., compact, aperture round, ribs very prominent." This small form, which may, perhaps, fall as a subvariety under *americana*, was found by Mr. D. B. Cockerell at Niagara Falls, on the Canadian side. When sending it to me he remarked: "The only place I found this variety was on the Canadian side, although the type was common everywhere else but where I found var. *costata*." I confess that the meaning of the last sentence is somewhat obscure to me. But the fact is stated of the existence of a small costate form in that locality. Any conchologists visiting Niagara Falls should be on the lookout for this *Vallonia*, as well as for others. Mr. Cockerell wrote me that the specimens in question had been accidentally destroyed.

8. *V. tenera* Reinhard.

Hel. tenera Reinhard, Jahrb. D. Mal. Ges., 1877, p. 322, T. XI, f. 4.

(?) *Hel. pulchellula* Heude, Moll. Terr. Fl. Bleu, 1882, p. 20, T. 8, f. 17.²⁷

(?) *Hel. pulchellula* Hilber, Sitzungsber. K. Acad. Wiss. Wien, LXXXVI, p. 3.²⁷

(?) *Hel. pulchellula* O. v. Möellendorff, Jahrb. D. Mal. Ges., 1884, p. 315.

Unfortunately, the original descriptions are not accessible to me. From two authentic specimens in the collection of the Academy, fresh and evidently mature, or nearly so, we can characterize *V. tenera* as follows:

Shell rather small and of the general appearance of *V. costata*, with spire little elevated, very depressed, conic, light grayish horn colored, thin and transparent, somewhat shining; surface with rather fine and dense membranous ribs, about 33–43 on the last whorl; umbilicus rather wide and regular, a little more widened for

²⁷ Cited from Möellendorff, *l. c.*

the last $\frac{1}{2}$ whorl; whorls rather more than $3\frac{1}{2}$, regularly increasing, a little angular at the periphery, with a rather deep suture, the last moderately wide, distinctly flattened above and sloping outward, somewhat expanding toward the aperture, ascending before, moderately descending in front, a little more so at the suture; aperture very oblique and inclined, transversely elongate, markedly flattened above, moderately curved below (not subangular) somewhat angular at the periphery, margins approximate, the superior more advancing in front than the inferior; peristome, except above, moderately and abruptly everted with a rather thin, almost glassy transparent, hardly white, lip.

Diam. maj. 2.3 (2.2) min. 1.9, alt. 1.0 mm.

Soft parts not examined.

Shanghai, China; Kobi, Nippon, Japan (Acad. Coll.) Dunca Yosky, (?) Japan (Nat. Mus. Coll.).

As far as I can judge from the few specimens seen, I believe *V. tenera* Reinh. is a well-characterized species.

To the kindness of Dr. O. v. Möellendorff, I owe three specimens of *V. pulchellula* Heude, from Shanghai, China. One of them has a diam. maj. of 2.3, the others of scarcely 2.2 mm.; the former corresponds exactly with those of *tenera* Reinh., described above, while the two smaller ones are somewhat different in coloration, which is rather yellowish horn, and in their umbilicus being a little narrower in the upper part and then more rapidly widening. In the collection of the Academy there are two specimens of *V. pulchellula* Hde. from China said to be authentic; one although not quite mature, agrees in every particular, as far as it goes, with *V. tenera*; the other is not quite fresh, diam. scarcely 2.2, and here also the umbilicus is first a little narrower and more rapidly widens in the latter part; the lip is quite thin, though distinct, the coloration somewhat indistinctly yellowish horn, the spire somewhat more elevated, and the last whorl descending very slowly, yet the suture being below the periphery at the aperture. This form is represented in Man. Conch., Pl. 33, fig. 53.

From all this we may conclude that *V. pulchellula* Hde. is not specifically distinct from *tenera* Reinh., the latter name having priority. The somewhat different form noted above, and rather closely corresponding in the two lots, which possibly or even probably, are from the same place, may represent a var. *pulchellula* Hde., if they agree with the original description, which I have not

seen. *V. tenera* is, at all events, distributed over eastern China as well as in Japan.

9. *V. patens* Reinhard.

Hel. patens Reinhard, Sitzungsber. Nat. Fr. Berlin, 1883, p. 43.

Hel. patens O. v. Möellendorff, Jahrb. D. Mal. Ges., 1884, p. 315.

Hel. pulchella Müller and n. sp. O. v. Möellendorff, ibid. 1881, p. 36.

"Shell small, flat, with scarcely projecting apex, with wide, perspective umbilicus, grayish white. Whorls $3\frac{1}{2}$, somewhat depressed, moderately increasing in width, separated by a deeply impressed suture, and with distant membranous ribs; the last scarcely descending toward the aperture. Aperture very oblique, transversely oval, with everted but scarcely thickened peristome; upper margin almost straight, lower margin symmetrically curved, insertions at the margins approximate. Diam. 2, alt. scarcely 1 mm.

"The species recalls *H. costata* as to the ribs, but differs from it in its smaller size, wider umbilicus, and more oblique aperture with slightly thickened peristome. It has been found by Dr. O. v. Möellendorff on the Powentschan, Prov. Chi Li, China, in company with *H. tenuilabris* A. Br., a species which seems to be widely distributed in northeastern Asia, while in our regions (Central Europe) it is only found fossil in the pleistocene loess. This fact is interesting in connection with the results of Nehring's investigations concerning the vertebrate fauna of the loess." (Original descr., translated; no figure).

Dr. O. v. Möellendorff (*l. c.*, 1884) thinks *V. patens* may be identical with *V. pulchellula* Hde. (see *tenera* Reinh.). I have seen no specimens.

10. *V. gracilicosta* Reinhard.

V. gracilicosta Reinh.,²⁸ Sitzungsber. Nat. Freunde, Berlin, 1883, p. 42.

Shell flat, with little prominent apex, widely umbilicated, of whitish-gray color. Whorls $3\frac{1}{2}$, convex, separated by a deep suture, with fine but distinct, rather crowded ribs; last whorl slightly angular around the umbilicus, strongly expanding toward the aperture, slightly descending to the same. Aperture moderately oblique, transversely oval, with strongly everted and broadly white-lipped peristome; upper margin little, lower margin more curved, almost obtusely angular. Margins at the insertions approximate and connected by a callus. Diam. 2.5, min. 2.0, alt. about 1 mm.

²⁸ O. Reinhard, über die von den Herren Gebr. Krause auf ihrer Reise gesammelten Pupa-, Hyalina- und Vallonia-Arten.

Collected on the Little Missouri, by MM. Krause. (Orig. descr., translated).

I have seen no authentic examples of this species. But there are four fresh specimens of a form from Logan Canyon, Utah, collected by Mr. Henry Hemphill, in the collection of the Academy labelled "*H. pulchella* var. *costata* Müll.," certainly not *costata*, but which I take to be *V. gracilicosta*, as they rather conform to the description.

The spire is quite low, but distinctly conic. The ribs of the shell itself are rather regular, about 40 on the last whorl, without membranous appendages. Such are not worn off, since there is no trace of them to be seen at the suture or umbilical part. Nucleus with indistinct microscopic revolving lines. The last whorl is slightly flattened above and below the periphery, thus being somewhat angular at the periphery and base, in its last $\frac{1}{4}$ slightly but distinctly ascending before it descends in front, somewhat more at the suture. Aperture of the form given in the above description, appearing slightly triangular. Diam. 2.6 mm.

A corresponding lot of four specimens from the same place and the same collector is in the National Museum Collection.

Near the preceding we have to range some fossil forms. In the southern part of New Mexico, near Eddy, in a dry "Salt Lake," some fine quartz sand with numerous minute fossil, or semi-fossil shells, was collected by a party of the Texas Geological Survey. The shells were picked out and kindly forwarded to me for examination by Mr. J. A. Singley. There were about fourteen land and fresh water species, extremely fragile and bleached. Among them was a number of *Vallonia* which I then named *costata* var., but they differ from that species in the more elevated spire, the last whorl markedly ascending, and the surface rather densely and somewhat irregularly striate, quite unlike *costata*. Whether they had membranous ribs when fresh, it is, of course, impossible to tell, but, from analogy with recent forms, it is probable that they had.

Two specimens, much like those from Eddy, were found among a number of minute land and fresh water shells in the same condition and with the same white quartz sand seen by Mr. W. F. Cummins, of the Texas Geological Survey, in Osborn's Julia Canyon, N. W. Texas, near the top of the bluff.

Both these finds are said to be quaternary, and it is believed that the species are not represented in the recent fauna of that part of the country. As a whole they suggest parts of a more northern fauna. A list of them will be published in another article.

Further studies of more material of all these forms will be necessary.*

11. *V. perspectiva*, n. sp.,²⁹ Pl. VIII, fig. F. Man. Conch., Pl. 33, fig. 39-46.

Shell small, with very wide perspective umbilicus, more widening for the last $\frac{1}{2}$ whorl, flat, or a little elevated above, with rather dense, somewhat regularly set, moderately strong membranous ribs (about 35 on the last whorl) and with finer striæ between them; nucleus without revolving lines; pale horn to colorless, thin, translucent; whorls $3\frac{1}{2}$, gradually increasing, a little flattened above and below the periphery, with a deep suture, the last rounded, comparatively narrow, little expanding toward the aperture, rather rapidly descending in toto; aperture very inclined and oblique, almost tangential, transversely (short) ovoid or oblong; peristome continuous, shortly but not abruptly everted except near the suture, without (or with a very thin) lip.

Diam. maj. 2.0, min. 1.7, alt. 0.7 mm.

Soft parts as usual in the genus; the liver, as seen through the shell, appears grayish brown. Jaw slightly arcuate, with rather fine irregular ribs. Radula with 77 transverse rows of 25 teeth: R: 3+2:7. There are 3 perfect laterals and the fourth resembles them closely, yet forms the transition from laterals to marginals, and even the fifth might rather range with the former, as its plate is distinct though small; its ectodont is two-pointed, and the peculiarly-formed mesodont rather long. The sixth is a marginal, with 2 distal cusps; the other marginals are wide and short, with 4 to 6 slender cusps, the mesodont being moderately longer than the others. The last 1 or 2 are very small, and their cusps indistinct even when highly magnified.

This is a North American species, which I saw first from Knoxville, Tennessee, where it had been collected by Mrs. Judge Andrews in damp moss on the cliffs above the Holston River. Later it was found in Jackson County, Alabama, by Mr. H. E. Sargent, and, among the specimens sent, there were a few living, so that I could observe the animal and examine at least the jaw and radula. Doubtless our species will be found at more localities in the Appalachian Mountains. In the Missouri River drift, from Eastport, Iowa, mentioned under *V. parvula*, there were four examples of this species, somewhat small, 1.8 and 1.9 mm. diam.

*See Appendix.

²⁹ S. notice in "Nautilus," V, No. 4, p. 101.

Those from Tennessee and Alabama show some slight variation. The size is from 1.7–2.1 mm. gr. diam., 2.0 being the average. On some specimens the aperture is not pear shaped as in most, but rather broadly rounded at the left side, as shown in *Man. Conch.*, Pl. 33, fig. 44. There is also some difference in the more or less strongly everted peristome. A few specimens from Alabama show a thin lip, but from its appearance it seems to be caused by some disease.

V. perspectiva can not be mistaken for any other species except *parvula*, which it resembles in size, coloration and the membranous ribs. But it is sufficiently distinguished by the wider umbilicus, the comparatively narrow last whorl, less expanding and descending in toto to the aperture, which is smaller and not circular; the continuous peristome and the absence of a lip. It holds a singular position also among the species with strongly descending last whorl and transversely elongated aperture by the comparatively more distant and regularly standing membranous ribs, and its small size.

12. *V. cyclophorella* Ancey, Pl. VIII, f. E. *Man. Conch.*, Pl. 33, f. 34–38, Pl. 32, f. 29.

“Resembles *tenuilabris* A. Braun, in its rather slight peristome, and *costata* in its sculpture. Umbilicus large (about 1 mm. diam). Whorls about 4, the last depressed above. Costulations fine; aperture oblique, nearly round. Diam. $2\frac{3}{4}$, alt. 1 mm.” This description has been communicated by Mr. Theo. D. A. Cockerell, with the note: “*V. cyclophorella*, collected at West Cliff, Colorado, has the animal entirely translucent, white (except the dark eyes). The liver, seen through the shell, is red-brown.”

As noted, this species has been collected over a wide range of the Rocky Mountains, and is in collections under different names. Colorado: North Park, Ingersoll collection, received from Mr. J. H. Thomson; E. A. Barber, Aug., 1874, in collection of the Academy (as *V. minuta* Say), West Cliff, Mr. Cockerell; South Park; Utah: American Fork Canyon, J. D. Putnam; Montana: Helena, Mr. Henry Hemphill (in Acad. Coll.); Idaho; Wyoming: Fort Bridger, Dr. Jos. Leidy; Washington: Walla Walla, Mr. Hemphill; Nevada: Hamilton (in Nat. Mus. Coll.); New Mexico (or Arizona), in Nat. Mus. Coll.

The above description would be insufficient to characterize the species. By the kindness of Mr. Theo. D. A. Cockerell, who sent me some authentic specimens from Colorado, and Mr. J. A. Thomson, who presented me his examples, collected by Ingersoll, I was

enabled to identify it, and now would add the following: Shell rather thin, pale or grayish-horn colored, or whitish translucent, ribs on the shell small, crowded (about 60 on the last whorl), with fine membranes, rather regular, often irregular (as in Man. Conch., Pl. 32, fig. 29), with fine striae between them; nucleus with slight, irregular, nearly obsolete revolving lines; suture moderately deep; last whorl somewhat widening toward the aperture, in its last $\frac{1}{3}$ distinctly ascending (Man. Conch., Pl. 33, fig. 37) then rather rapidly descending, somewhat more at the suture, so that the margins are much approximate; aperture transversely elongate; superior margin markedly less curved than inferior; peristome slightly everted, except near the suture, thin, without a lip. Most specimens are of a rather dull surface, but those from Walla Walla are shining, the shell almost colorless, thin and transparent, and rather large.

Greater diam. 2.7, lesser 2.2 alt. 1.2 mm.

I have seen no living animals. The jaw and radula were examined in softened specimens. The former appears rather low, somewhat truncated at the ends, with rather stout, irregular rib-striae, except near the side-ends, which are smooth. The radula (Pl. VIII, f. E) has 63 transverse rows of 25 teeth; 5 laterals, the fifth though, having a small plate; its ectodont is simple in most, slightly two-pointed in a few teeth. The first marginal (sixth tooth) is somewhat different from the following: the plate is distinctly visible behind the "reflection," the latter markedly tapering from the proximal end; the mesodont comparatively large, the others 2-3, small. In the following marginals the cusps are comparatively small, about 6, the mesodont little exceeding the others, and only in the 2-3 first teeth; the last ones are very short and with very small cusps.

There is some variation in the configuration of the shell as has already been pointed out. Some specimens from Hamilton, Nevada, in the Nat. Mus. Coll., have a distinct though not strong lip.

13. *V. tenuilabris*, A. Braun.

Hel. tenuilabris, Vers. D. Naturf., Main, 1843, p. 143.

Hel. tenuilabris Sandberger, Conch. d. Vorw. p. 891, T. 36, f. 14.

Hel. tenuilabris Westerlund, Fauna, I, p. 15.

"Shell with umbilicus open, and rapidly widening at the aperture, depressed convex, with prominent, almost papilliform apex, with fine and acute, crowded ribs, grayish horn-colored; whorls 4-4 $\frac{1}{2}$, somewhat convex, the last somewhat expanding in front, grad-

ually deep descending; suture rather impressed; aperture very oblique, little crescentic, transversely oval, rounded with the margins much approximate; peristome widened [everted], thinly lipped, yellowish horn-colored, inferior margin reflexed. Size 3 : $2\frac{3}{4}$ –2 mm.

(Siberia : Jarzowa, Selo at $60^{\circ} 10'$, and Werschininski $68^{\circ} 55'$; fossil in southern Germany.)" Translated from Westerlund, Fauna.

I have seen no recent Asiatic specimens. From Europe there is a fossil from Kroellwitz, near Halle on the Saale, Saxony. Ten specimens before me, obtained from two different parties under the name of *Hel. tenuilabris* A. Br., are nearly alike except for slight differences in size, represented in Man. Conch., Pl. 33, fig. 30–33. This is a shell probably well-known among European conchologists, but there are some characters which do not agree with the above description. They are in good condition, appearing remarkably fresh for fossils, more or less translucent, and in most the epiconch is preserved. The surface is rather finely striate, but not acutely ribbed. There is also no trace of a difference in coloration of the apertural part and the rest of the shell; this would, of course, be of little importance if the shells are weathered and opaque, but in the state of preservation they present, it is significant. The whole shell is equally colorless, and must have been glassy transparent when fresh. There is also no trace of a lip. The size is somewhat larger: greater diam. 3.1–3.3, lesser 2.4–2.6, alt. 1.7 mm.

From all this it is evident that the Kroellwitz shell can not be identical with *tenuilabris* as described. It would be hasty to take it for a different species before authentic specimens can be compared. We may eventually propose for the fossil the varietal name *saxoniana*. The last whorl is very distinctly ascending before it descends to the aperture, as shown in Man. Conch., Pl. 33, fig. 33; this is also seen from above (fig. 30). Very probably *V. tenuilabris* presents the same character; apex almost papilliform, which becomes apparent at once if we compare fig. 32. But this, as has been pointed out, appears to be a characteristic, not of a single species, but of a whole group. From its size, color and the ribbed surface we may conclude that *V. tenuilabris* is related to *V. cyclophorella*.

It has been noted above that I received another form under the name of *V. tenuilabris*, from Germany. This is of quite a different type (see under *V. declivis* p. 257).

14. *V. mionecton* Boettger.

Hel. adela West. var. *mionecton* Btg., Zool. Jahrb. IV, 1889, T. 27, f. 11.

Hel. tenuilabris var. *mionecton* (Btg.), West. Fauna, I. Supl. p. 120.

Vallonia mionecton Btg., cit. in Nachr. Bl. D. Mal. Ges. 1892, p. 125 (O. Rosen.)

"Smaller, more depressed, almost regularly, very finely rib-
striate; whorls only 3, the last, as also the upper margin of the
peristome, somewhat angular above; size $2\frac{3}{8}$ – $2\frac{1}{2}$: $1\frac{1}{8}$ mm. (Trans-
Caucasia, on the summit of the Agh-dagh in the Kopet-dagh, at 9–
10,000 feet). Dr. Boettger ranges this form under my *adela*, but
the excellent figures show the last whorl much widened in front,
deep descending above, margins much approximate, almost con-
nected, etc." From Westerlund, Fauna, *l. c.* translated.

In Baron O. Rosen's article, evidently influenced by Dr. O.
Boettger, *V. mionecton* is treated as a species, and published.

V. mionecton var. *schamhalensis* Rosen.

Differs from the type in the shell being smooth [*polita*] not rib-
striate. Schamhala, Prov. Chorassan, Persia.

I have seen no specimens of either the type or variety.

15. *V. ladacensis* Nevill.

Scient. Res. of the Sec. Yarkand Miss., Moll., p. 4—Mts. Centralasiat. Moll.,
1882, p. 3, T. 3, f. 3.—Westerlund, Fauna, I, p. 15.

"Shell widely umbilicated, depressed, with little elevated spire,
densely and finely ribbed (ribs sometimes almost obsolete), grayish
white; whorls $3\frac{1}{2}$, somewhat convex, the last rounded, descending
in front; aperture very oblique, transversely pear-shaped, peristome
everted ("reflexed"), rather thin, with margins much approximate,
inferior margin more curved. Size $3\frac{1}{2}$: $1\frac{1}{2}$ m. (Central Asia, near
Iskardo in Tibet)." Descr. from Westerlund, *l. c.* translated.

V. ladacensis var. (?) *asiatica* Nevill.

Hel. costata var. *asiatica* Nevill, *l. c.*

Vall. ladacensis var. *asiatica* Nevill, Reinhard, über die von den Herren Gebr.
Krause auf ihrer Reise gesammelten Pupa-, Hyalina- und Vallonia-Arten; Sitzungs-
ber. der Ges. Naturf. Freunde, Berlin, 1883, p. 42.

Reinhard says (*l. c.*) that on Pyramid Island, Alaska, a *Vallonia*
has been collected by MM. Krause which is identical with *asiatica*,
except for its somewhat smaller size. He states that the latter
comes nearer *ladacensis* than *costata*, under which it has been
ranged by the author. Mr. Pilsbry believes that the Alaska form
is not the same as the Asiatic.

I have seen no specimens of either the type or the variety, which also has been regarded as a species, and am unable to judge about them.

KEY TO SPECIES OF VALLONIA.

It is necessarily difficult to give a synopsis of the species of *Vallonia* based on the shell alone. The characters are quite interwoven among the groups and species, and several attempts to found natural groups upon one, or even a few prominent features proved to be failures. Yet there are such natural groups, though not well-defined, and the following table may serve to characterize them and the subordinate groups, at the same time affording a means of identifying specimens, definitely or approximately, without going over all the descriptions.

GROUP I (of *pulchella*). Aperture crescentic, forming $\frac{4}{5}$ to $\frac{5}{6}$ of a circle (not transversely elongated), with ends of margin distant, little or moderately inclined and oblique; suture not markedly descending to the aperture or not more so than the last whorl; shell of medium size; surface rarely or never ribbed; nucleus, as a rule, smooth (?).³⁰

A. Last whorl not, or scarcely descending

1. Peristome with a strong white lip,

a. Peristome decidedly everted; shell and umbilicus rather symmetrical; surface finely striate *pulchella*.

aa. Peristome scarcely everted; shell and umbilicus elongate, surface smooth or very finely striate; spire small and low *excentrica*.

2. Peristome without a lip, little everted; whorls 4-4½ diam. 2.5-3 mm. *adela*.

B. Last whorl gradually and steadily descending in toto, peristome not everted; lip thin or wanting

1. Surface microscopically striate, appearing almost smooth; lip thin or wanting *declivis*.

2. Surface with fine membranous ribs, peristome straight and thin, without a lip *pollinensis*.

GROUP II (of *costata*). Aperture almost circular or transversely elongate, with margins approximate; peristome distinctly everted, with a white lip; last whorl moderately or not descending in front, suture more descending, surface (as a rule) with distinct ribs or rib-striae.

³⁰ In *adela* and *pollinensis* the nucleus is unknown.

- A. Aperture rather circular, surface with membranous ribs (rarely smooth, with fine striæ in place of ribs)
1. Of medium size or small, pale or reddish horn colored.
 - a. Of medium size (average 2.5 mm.) last whorl usually a little descending in front *costata.*
 - aa. Small (2 mm. or less), back of last whorl not descending. *parvula.*
 2. Rather large (2.7 mm.) whitish; riblets membranous, very fine and crowded *albula.*
- B. Aperture transversely elongate; superior margin much less curved than inferior.
1. Rather small (2.3 mm.) and thin shelled, with fine membranous ribs, light grayish, transparent; lip moderate *tenera.*
 2. Rather stout (diam. 2.6 mm.), with ribs on the shell without membranous appendages; lip strong, white *gracilicosta.*
 - a. Last whorl not descending; umbilicus very wide; diam. 2 mm.; otherwise like group III, surface with membranous ribs *patens.*
- GROUP III (of *cyclophorella*). Aperture transversely elongate, elliptic or pear-shaped, inferior margin more curved, but not angular; last whorl descending in toto after ascending previously; peristome moderately everted, without a lip (as a rule).
- A. Small, diam. 2.0 mm. or less; horn colored; umbilicus very wide, perspective, surface with membranous ribs, peristome continuous *perspectiva.*
- B. Larger, with very fine crowded ribs, or almost smooth; peristome not continuous.
1. Diam. 2.4-2.5 mm.; whorls 3; very finely rib-striate *mionecton.*
 2. Diam. 2.6-3.3 mm.; whorls 3½-4.
 - a. Diam. 2.6-2.8; surface with fine, somewhat irregular, crowded membranous ribs; color grayish-white to grayish-horn (rarely with a thin white lip) *cyclophorella.*
 - aa. diam. 3.0 or more; surface finely ribbed
 - b. spire rather elevated; diam. 3 mm. *tenuilabris.*
 - bb. spire little elevated; diam. 3.5 mm. *ladacensis.*

TABLE OF GEOGRAPHICAL DISTRIBUTION.

1. *V. pulchella* Müll.: circumboreal (eastern Asia? Pacific slope of North America?) Australia, Mauritius (introduced.?).
2. *V. excentrica* Sterki: all Europe; eastern North America.

3. *V. adela* West.: Central Europe; fossil in Sweden.
- 3a. *V. declivis* Sterki: Central Europe.
4. *V. pollinensis* Paul.: Italy.
5. *V. costata* Müll.: circumboreal; Australia.
6. *V. albula* Sterki: Northern North America.
7. *V. parvula* Sterki: North America.
8. *V. tenera* Reinh.: China, Japan.
9. *V. patens* Reinh.: China.
10. *V. gracilicosta* Reinh.: Rocky Mountains.
11. *V. perspectiva* Sterki: North America.
12. *V. cyclophorella* Anc.: Western North America.
13. *V. tenuilabris* A. Br: Asia; fossil in Germany.
14. *V. mionecton* Bttg.: Western Asia.
15. *V. ladacensis* Nev.: Central Asia; Alaska.

APPENDIX.

After this paper had been written, Mr. Wm. H. Dall kindly forwarded me many additional specimens of *Vallonia* from the National Museum. I would add the following notes upon them:—

V. pulchella Müll was largely represented from Madeira and Bermuda. The specimens from the latter locality are of a somewhat peculiar form, being composed of only three comparatively large whorls, the umbilicus is first quite narrow, rapidly widening for the last $\frac{1}{2}$ whorl.

V. excentrica seems to be widely distributed in Great Britain, being represented from different places.

V. costata: The specimens assigned to this species reported from Iowa, Nebraska, etc., must be referred to the following, the distribution of which in the United States should be further studied.

V. gracilicosta. There was among the National Museum material over a hundred specimens from drift on the Missouri River, collected near Fort Berthold, Dak. They are all dead shells, yet some of them are in good condition, of 2·5–2·8 mm. diam. They, especially the smaller, somewhat resemble *V. costata*, while the fresh examples of the two lots from Utah mentioned above are decidedly different. As far as I am able to judge from the material seen, the two species are distinct, constantly differing in a number of points. In *V. gracilicosta*, also averaging larger, the whorls, especially the last, are more depressed above, the aperture is more inclined and oblique, much more curved below than above, and

somewhat angular at the periphery; the shells show distinct ribs and the membranous "ribs" upon them are quite small and fine, while in *costata* the ribs are quite small; the membranes are as a rule, coarse. In the former, the ribs are also more numerous, and more oblique, especially as seen from above. The lip, in fresh specimens, is pure white, never so in *costata*, and of a somewhat different form.

As said above, the specimens seen from the states west of the Mississippi, must be referred to *V. gracilicosta* instead of to *costata*.

EXPLANATION OF PLATE VIII.

(Plates 32 and 33 referred to throughout the text will be found in Pilsbry's continuation of Tryon's Manual of Conchology (2), VIII.

Fig. A-F Radula, enlarged about 900 diam. The first laterals and last marginals are always represented, so that the last gives the number in the half transverse row.

Fig. A. Radula of *V. pulchella*; 3 is nearly like 4 in B.

Fig. B. Radula of *V. excentrica*.

Fig. C. Radula of *V. costata*.

Fig. D. Radula of *V. albula*.

Fig. E. Radula of *V. cyclophorella*.

Fig. F. Radula of *V. perspectiva*.

Fig. G. Radula of *V. pulchella*, the central and first lateral in the first (anterior) transverse rows, with cusps worn off.

Fig. H. Jaw of *V. pulchella* as seen under moderate enlargement, cutting-edge below, as in all figs: scale about 150 : 1.

Fig. I. The same, another specimen, enlarged nearly 300 diam.; a b the posterior plate, extending backward into the tenaculum membrane t t.

Fig. K. The same, another specimen, as seen in profile.

Fig. L. The same, median section (partially diagrammatic).

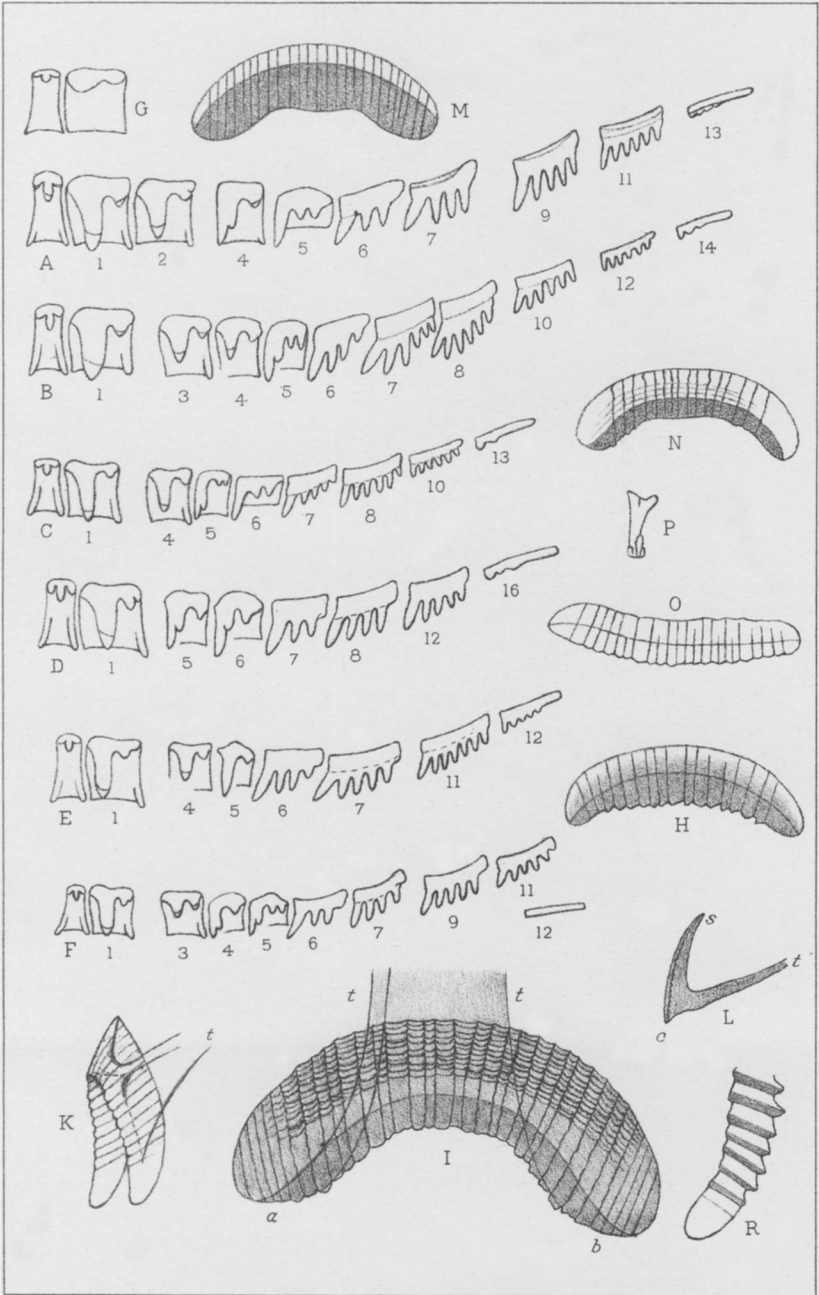
Fig. M. Jaw of *V. excentrica*.

Fig. N. Jaw of *V. costata*.

Fig. O. Jaw of *V. albula*, extended.

Fig. P. Central tooth of the radula (of *V. parvula*), half profile view.

Fig. R. One-half jaw of *V. parvula*, seen obliquely from above.



Edwin Sheppard, del.

Geo. S. Harris & Sons Lith. Phila.

STERKI ON VALLONIA.